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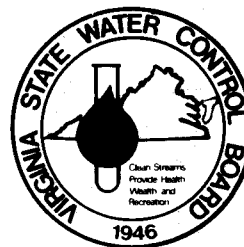
WISE-DICKENSON COUNTY GROUNDWATER

PRESENT CONDITIONS
AND PROSPECTS

by

Michael R. Dovel

SOUTHWESTERN REGIONAL OFFICE



COMMONWEALTH OF VIRGINIA

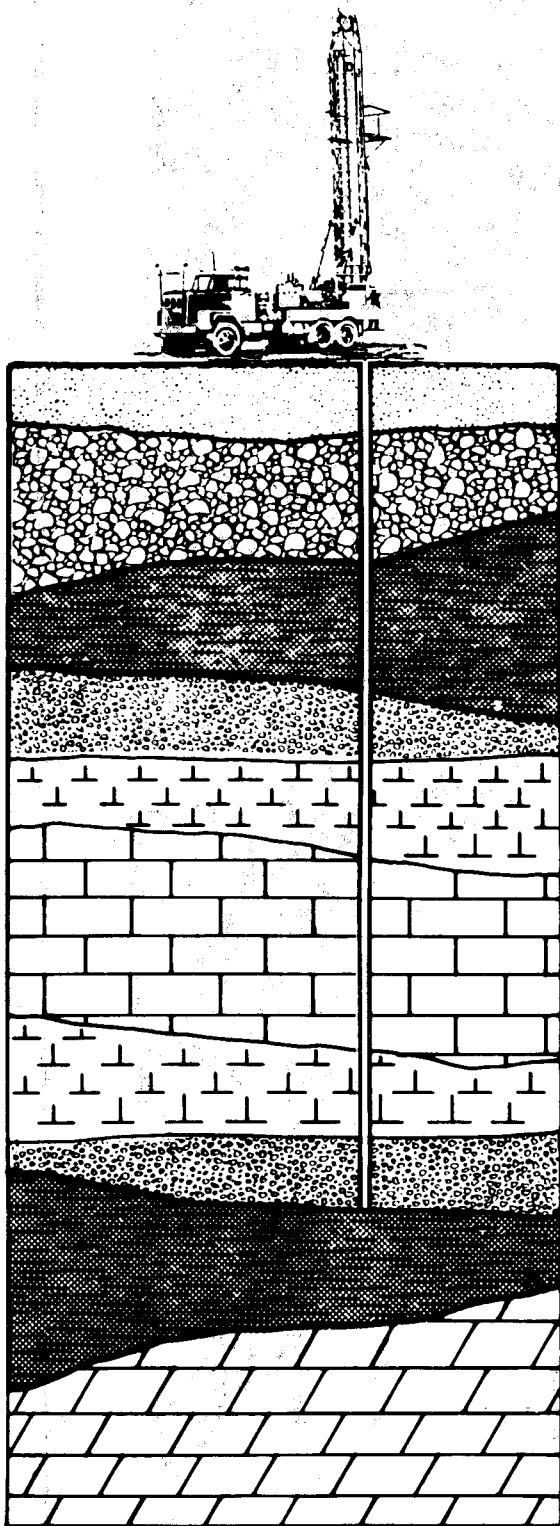
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BUREAU OF SURVEILLANCE AND FIELD STUDIES

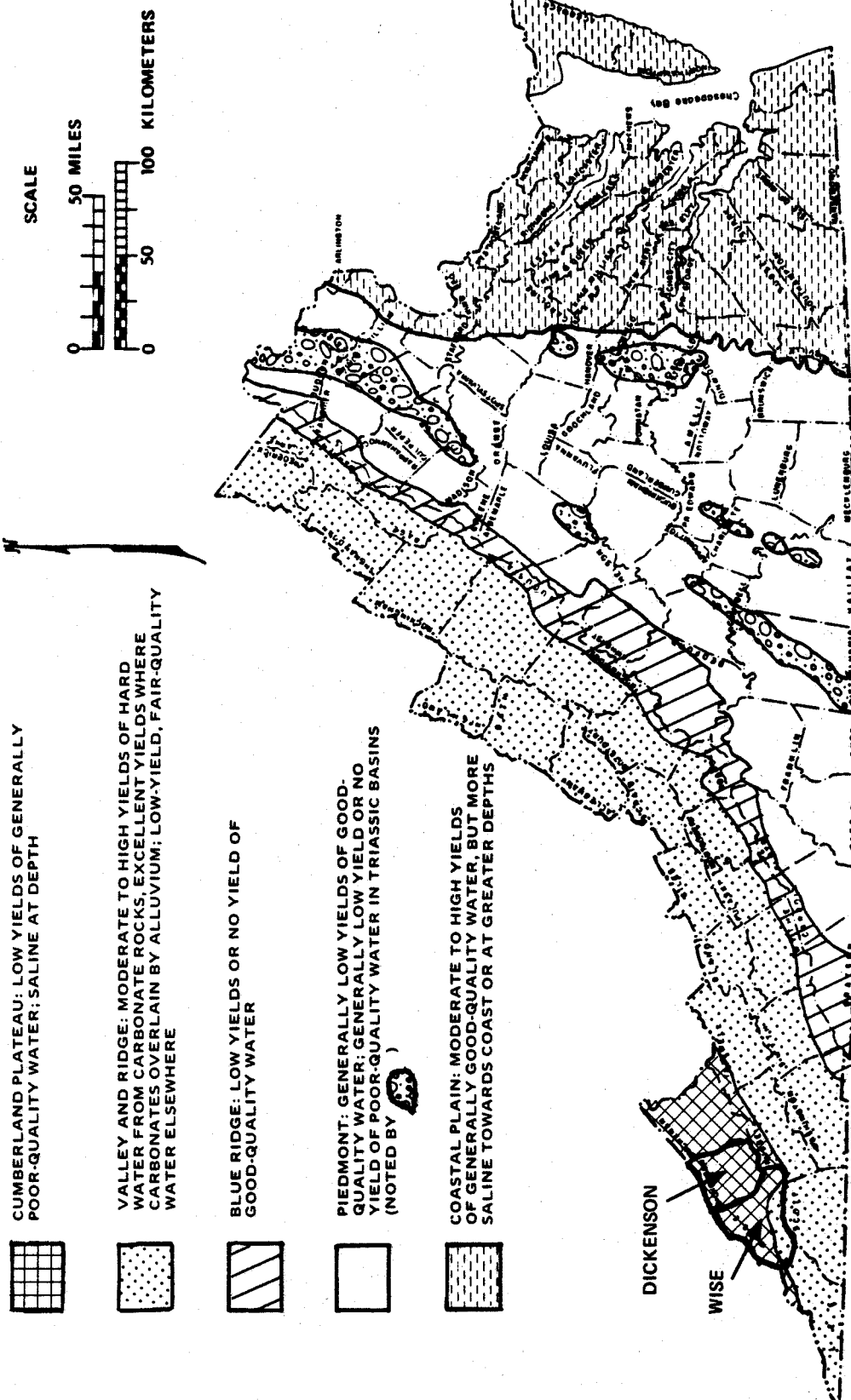
Richmond, Virginia

Planning Bulletin No. 333

June 1983



GROUND WATER CHARACTERISTICS OF THE PHYSIOGRAPHIC PROVINCES IN VIRGINIA



Source: Virginia State Water Control Board - BWCM

Frontispiece

WISE-DICKENSON COUNTY GROUND WATER

Present Conditions and Prospects



by

Michael R. Dovel

SOUTHWESTERN REGIONAL OFFICE
VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF SURVEILLANCE AND FIELD STUDIES
RICHMOND, VIRGINIA
PLANNING BULLETIN NO. 333
JUNE 1983

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ACKNOWLEDGEMENTS

The writer would like to thank the numerous individuals and organizations who provided information and assistance toward this report. The writer would like to express his special appreciation to the scores of people who allowed access to their wells for sampling. The Wise and Dickenson County school staffs were extremely helpful in allowing water samples to be taken from school wells. The information provided by Funk Drilling Company and Keen Drilling Company is appreciated by the author. The assistance provided by the engineering staff of the State Health Department in Abingdon, and the summer field assistance of Mr. David Turpin are greatly acknowledged.

FOREWORD

This report is part of a continuing series that is intended to provide a summary of the ground water resources for every county in the Commonwealth.

The purpose of this particular report is to gather the available ground water data for Wise and Dickenson Counties, and to present it so that it might be used effectively by governmental agencies, industry, developers, investors or individuals in evaluating the existing ground water situation and their future requirements.

A growing population, expanding industry, and a relentless pattern of increased per capita water consumption all combine to place ever-increasing demands upon the water resources of a region. Ground water, often a neglected but valuable resource, often can play an important part in meeting these needs.

This report is directed primarily toward the layman, and it is intended broadly to assist the ground water user or developer. More detailed studies or specific ground water problems may require the services of a consulting hydrogeologist.

It is the function of the State Water Control Board to be at the public's service for general information and governmental action.

WISE-DICKENSON COUNTY GROUND WATER

PRESENT CONDITIONS AND PROSPECTS

By

Michael R. Dovel

ABSTRACT

All of Dickenson County and most of Wise County lie within the coal fields of Southwest Virginia, where they account for some of the largest productions of bituminous coal in the Commonwealth. The remainder of Wise County lies within the Valley and Ridge Physiographic Province.

The increased demand for coal as a domestic source of energy will require the expansion of both surface and subsurface mining operations. Population will increase, meeting the demands of an expanding work force. Protection of the existing ground water resources and its careful utilization in the future will help fill the anticipated increased requirements for water by both industry and population.

The topography of the coal fields in Wise and Dickenson Counties is formed from a raised plateau which has been eroded into a complex group of ridges and narrow, steep-walled, flat-bottomed, V-shaped valleys. The valley bottoms are flood plain deposits of boulders, cobbles, sands and clays which have been transported from the highlands. They are seldom more than 30 feet (9.1 m) thick.

Stream flows vary greatly throughout the year, with even the largest streams diminishing to a trickle in dry weather. The steep-sided valleys quickly exit rain water, reducing the volume of recharge into the water table. The denuding of land for strip mining operations hastens runoff even further.

Much of Wise County and nearly all of Dickenson County have, near their surface, rocks of Pennsylvanian age, which is part of the greatest coal-producing periods in the earth's history. They are mostly shales, sandstones and coal beds. Shales usually produce only small quantities of water. The voids between the grains of the sandstones are often filled with recemented mineral matter, clay and silt-sized particles, and mica flakes, reducing their ability to transmit and store water. Fractures and fissures in the rocks are often closed at depths below 400 feet (122 m) due to the weight of the overlying strata. This diminishes both the volume and flow of ground water. Below 400 feet (122 m) the water becomes increasingly salty.

The portion of Wise County within the Valley and Ridge Physiographic Province is characterized by a rolling topography that is reflective of the carbonates and shales that underlie it. The soil cover in this region is thicker than it is in the coal fields, and it weathers to a more fertile, silty clay.

The ground water in the coal fields of Dickenson and Wise Counties is typically slightly acid, irony, somewhat hard and often contains compounds of sulfur. It may also contain methane and hydrogen sulfide gases. The ground water in the Valley and Ridge Province in Wise County is generally of better quality, although it may be harder, and

it is more prone to contamination. A typical water well is illustrated in the report, along with a recommended technique for venting the well to reduce the danger of accumulating gases. Also discussed are methods for reducing iron, manganese, corrosiveness and bacteria from the ground water.

The largest wells in the two counties are used to serve coal mining operations. These wells tend to skew the data toward higher than normal yields, because inadequate yields are usually not reported.

The report discusses the methods which would be necessary to develop large-scale ground water supplies. This would involve placing several wells in a valley bed by a large stream, alternate pumping, proper well depths and adequate casing. Also discussed are ground water problems such as depletion due to overpumping or infiltration into abandoned mines, and quality deterioration caused by mining operations and inadequate landfills.

The report concludes by pointing at the increased demand for ground water as a source for water supplies in the future, and the need to obtain sufficient information to protect existing ground water resources, and plan for its future use.

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CHAPTER I

INTRODUCTION

General - Wise County

Wise County is located in southwestern Virginia (Plate 1), and it lies within both the Valley and Ridge and Cumberland Plateau Physiographic Provinces (Frontispiece). The 412-square mile (1,067.1 km²) county is bounded on the northeast by Dickenson County, Virginia; on the east by Russell County, Virginia; on the south by Lee County, Virginia; and on the west, northwest and north by the Kentucky counties of Letcher, Harlan and Pike, respectively.

The population of Wise County is 43,863.¹ Norton, which is the county's only incorporated city, is centrally located, with a population of 4,757. The remaining inhabitants are scattered throughout the county, principally in six towns that radiate from Norton. They are: Wise (population 3,894), the county seat, 4 miles (6.4 km) to the northeast; Pound (1,086), 15 miles (24.1 km) north; Appalachia (2,418), 11 miles (17.7 km) to the west; Big Stone Gap (4,748), 14 miles (22.5 km) to the west; Coeburn (2,625), 11 miles (17.7 km) east; and at the southeast corner of the county, 24 miles (38.6 km) from Norton, is the Town of St. Paul (973).

¹ U. S. Department of Commerce, Bureau of the Census, 1980.

The county lies largely within the coal fields of southwestern Virginia, and it is one of the State's largest producers of bituminous coal. In 1977, 31¹ percent of the county's non-agricultural wage and salary employment was in mining. Other county industries include the manufacturing of coke, lumbering, the quarrying of carbonate rocks for aggregate and sandstone for sand, and to a small degree, agriculture. Farms occupy only 10 percent of the land, with most farm income being derived from dairy cattle and apple orchards.

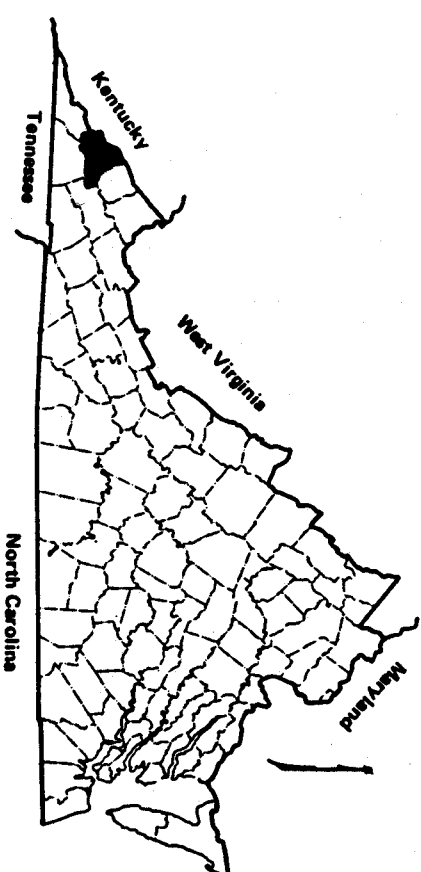
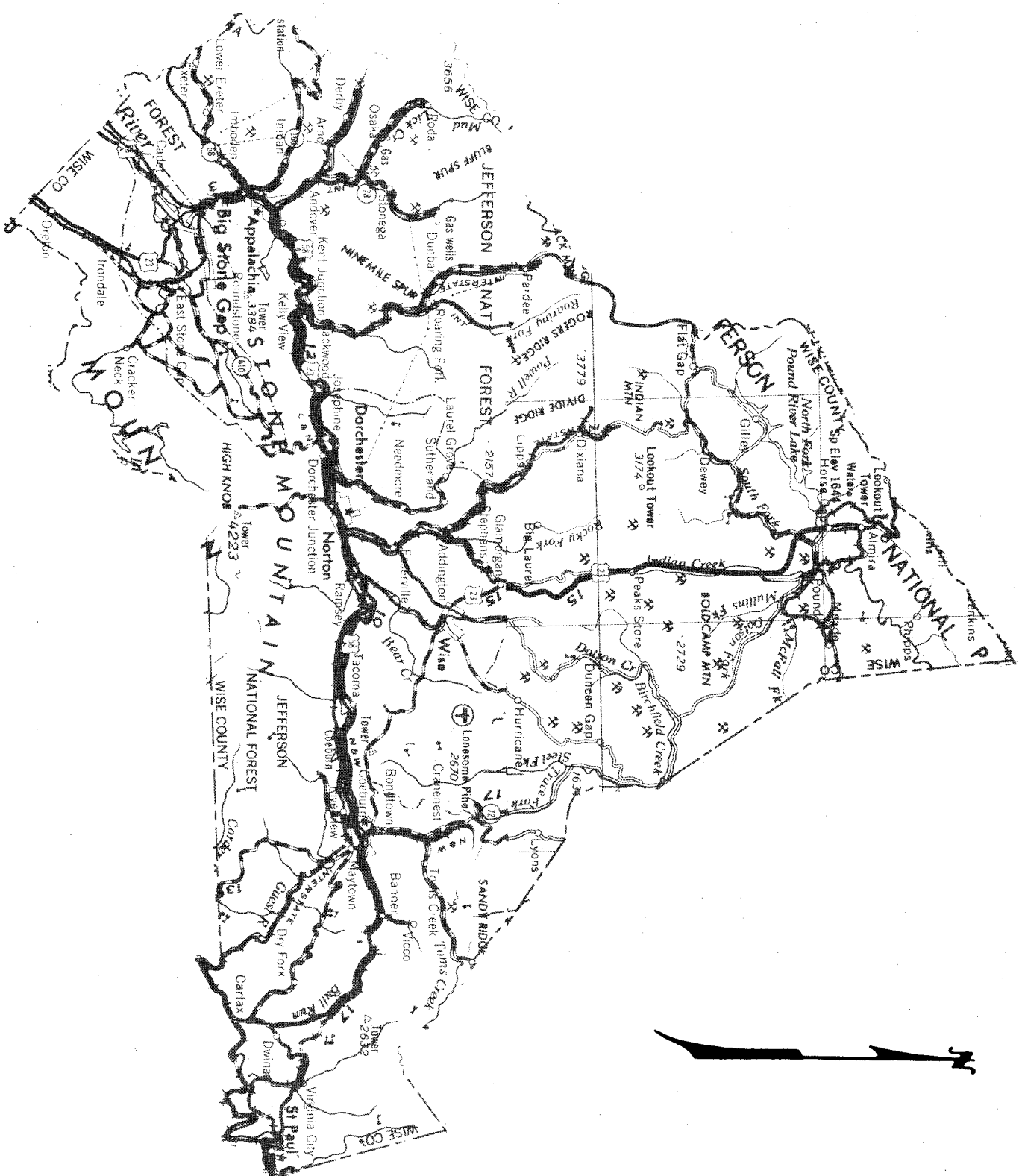
Manufactured items consist largely of dairy products, soft drinks, concrete, concrete blocks, lime, and mining machinery and equipment.

General - Dickenson County

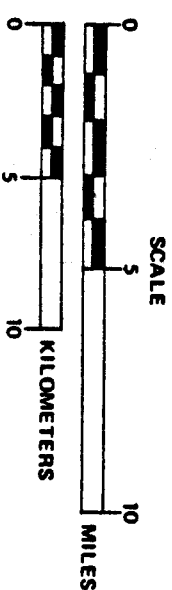
Dickenson County encompasses a total area of 335 square miles (867.7 km²) which lie totally within the Cumberland Plateau Physiographic Province (Frontispiece). It is also entirely within the Southwest Virginia coal fields, being the third largest producer of bituminous coal in the Commonwealth. It is bordered on the east, south and west by the Virginia counties of Buchanan, Russell and Wise, respectively. Pike County, Kentucky, forms the northern border.

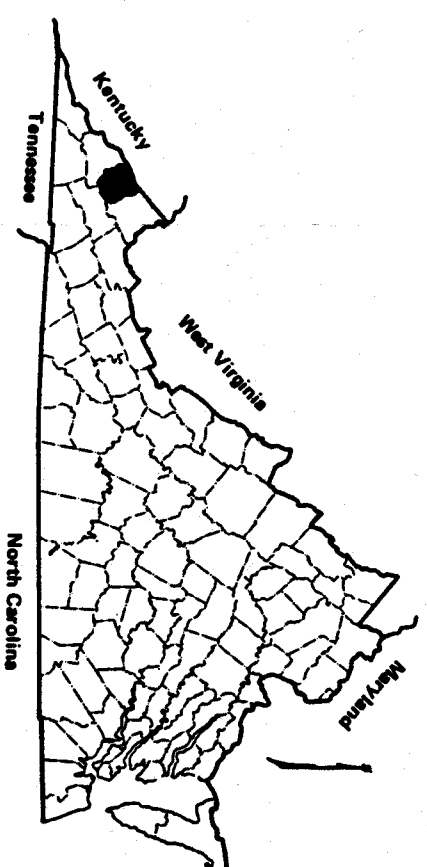
¹Virginia Employment Commission, Population and Employment Data, compiled by the LENOWISCO Planning District.

INDEX MAP OF WISE COUNTY

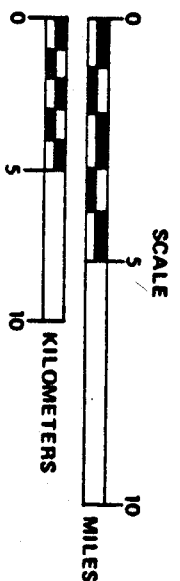


County Area : 412 Square Miles
 1,067 Square Kilometers
 County Population : 43,863 (1980)





County Area : 335 Square Miles
868 Square Kilometers
County Population : 19,806 (1980)



The population of 19,806 is largely rural, the main exceptions being the county's two incorporated towns: Clintwood, the county seat, with a population of 1,369, which is in the south-central portion of the county's northwest quadrant, and Haysi (371), located in the center of the northeast quadrant.

The main employer in the county is the mining industry, which accounts for nearly 80 percent of total employment. Other industries in the county are clothing, timber, agriculture and tourism. Only about 15 percent of the county is in agriculture, due largely to the rough terrain and thin soil. Most cash farm income is derived from cattle, tobacco and fruit. Nearly 80 percent of the county is forested, with the Jefferson National Forest extending throughout the county's northern border.

One of the most spectacular tourist attractions in the region is the Breaks Interstate Park, located at the northwestern corner of the county. The Russell Fork River has carved a 1,600-foot (488 m) deep, 5-mile (8.1 km) long gorge, known as the Breaks of Cumberland, through the underlying rock. Other tourist attractions in Dickenson County are the John W. Flannagan Reservoir on the Pound River, the Cumberland Museum in Clintwood, and Camp Zarahemla, approximately 15 miles (24.1 km) west of Clintwood.

¹U. S. Department of Commerce, Bureau of the Census, 1980.

Methods of Investigation and Data Assembly

The information presented in this report largely has been gathered from publications of local, state and federal agencies, private organizations, drilling contractors' Water Well Completion Reports, and the files of the State Water Control Board and the Virginia Department of Health.

Water samples for analysis are spigot samples collected either specifically for this report, or as part of the regular ground water monitoring and surveillance program of the State Water Control Board. An additional source of water quality information is the Pollution Response Program (PRP), maintained by the Board for the specific purpose of responding to citizens' reports of water pollution of any type. This includes the pollution of ground water by accidental or intentional spills of hazardous chemicals, oil, gasoline, refuse or industrial wastes. Water sample testing was performed either by the Board's laboratory in Abingdon or the Consolidated Laboratory in Richmond.

All water well information and the results of laboratory analyses used in this report are on file with the State Water Control Board in Richmond, and in the Board's Southwest Regional Office in Abingdon. These data have been placed in computer storage and are updated quarterly. The printout of this information was used to compile Appendices B, C, E and F.

Water Well Numbering System

Every well on file with the State Water Control Board is assigned two groups of numbers. The first group consists of a

3-digit series that indicates the county. For example, Wise County has been given the prefix 197, and Dickenson 125. The other group of numbers is a sequential list that has been given to the water wells upon receipt of their Water Well Completion Reports. This second series is unique to the well to which it has been assigned, and it is never reused. Although some water wells may be dropped from the computer printout, usually due to the lack of specific data, all such information remains on file with the State Water Control Board.

CHAPTER II

PHYSICAL SETTING

Topography - Wise County

It would be best to describe the topography of Wise County as being divided into two distinct types, each reflective of the geological conditions which underlie them.

Approximately 80 percent of Wise County is underlain by the nearly flat-lying rocks of the Cumberland Plateau. With the exception of a small, gently rolling plateau near Wise, much of the remaining Cumberland topography is in the form of narrow, steep-walled, V-shaped valleys that are drained by fast flowing streams with shallow, rocky bottoms. This would at first appear to indicate a rather youthful topography. Indeed, referring to the area as a plateau seems inappropriate. However, upon closer observation, it is revealed that these steep walls are caused by the nearly horizontal, weather-resistant strata which form nearly vertical slopes on their exposed, weathered outcrops.

Dissection of the former plateau has been so extensive that few traces of it remain among the resulting hills and valleys. Although dissection has been vast, it has not been great enough to produce wide valleys. However, around the Town of Wise, highly resistant sandstones and conglomerates have been sufficiently strong to blunt the effects of weathering, and, consequently, much of the character of a plateau remains.

The valleys of the coal fields in the southern part of the county are in older and more easily weathered strata than the valleys to the north, and, consequently, they have a less stark, more rounded character.

Rocks of the Valley and Ridge Physiographic Province underlie the remaining 20 percent of Wise County. They crop out in two places in the county: a small area in the extreme southeastern corner, around St. Paul; and a much larger, 5-mile (8 km) wide, 12-mile (19.3 km) long, northeast-trending salient that extends from beyond the county's southwest border almost to Norton (Plate 5). This latter feature presents the most dramatic topography in the county. It is caused by a large plunging anticline, or arch in the rocks, that has had its core eroded away, forming Powell Valley, and leaving the more resistant strata to form the mountain ridges which rim the valley on three sides. The anticline's nose and southern limb form Powell Mountain; the northern limb forms Stone Mountain. This ridge extends to the southwest for approximately 140 miles (225.3 km), broken in only two places: Pennington Gap in Lee County, Virginia; and Big Stone Gap in Wise County, where it has been cut by the main stream of the Powell River. This breach was crucial to the development of the coal fields in Wise County, for it provided a water grade through which the railroads could enter.

The highest point in the county is High Knob on Powell Mountain, with an elevation of 4,223 feet (1,287.2 m) above mean sea level. The county's lowest point is nearby on the floor of Powell Valley, where elevations of approximately 1,700 feet (518 m) are not uncommon.

A small asymmetrical ridge extends down the center of Powell Valley, the result of an underlying, southeasterly dipping stratum of weather-resistant sandstone. Other modest topographic features on the valley floor include small sinkholes among the carbonates, and the gently rolling hills that typically reflect the Valley and Ridge carbonates and shales that lie beneath them.

The Wise County-Kentucky border is formed by the crest of Pine Mountain, a feature that forms the northern boundary of the Cumberland Block. This is a northeast-southwest trending ridge that extends from Russell Fork in adjacent Dickenson County into Tennessee.

Topography - Dickenson County

Dickenson County lies entirely within the Cumberland Plateau Physiographic Province, with an extremely rugged topography that has been formed as a consequence of erosion upon the nearly horizontal strata that are beneath the county. Dissection of the up-lifted plateau has been extensive, resulting in a vast number of steeply walled, V-shaped, narrow valleys.

The maximum relief in Dickenson County is approximately 2,300 feet (701 m), representing the difference between the highest point on Pine Mountain near Jesse Gap, with an elevation of 3,149 feet (959.8 m), and the lowest point located where Russell Fork exits the county at the Kentucky border.

Pine Mountain, the crest of which forms the Dickenson County and Kentucky border, is the county's most prominent topographic feature. It has been formed as the result of the Pine Mountain

Fault (Plate 6), which, in turn, forms the northwestern edge of the Cumberland Block. Two other ridges are important topographic features in Dickenson County. They are: Sandy Ridge, which parallels the Dickenson and Russell County boundary; and the northerly-trending Big Ridge, which extends from Sandy Ridge and also serves to divide the Cranesnest and McClure Rivers.

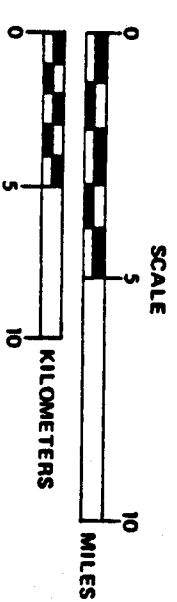
The dramatic Breaks of Sandy is a Dickenson County topographic feature that must not escape mention, for it forms the deepest gorge in the United States east of the Mississippi River. The northerly flowing Russell Fork has carved itself into the sandstones and shales to a depth of nearly a thousand feet (305 m), leaving nearly vertical walls.

Drainage - Wise County

The drainage of Wise County is carried to three major drainage basins (Plate 3), each of which is fed by numerous streams, forming, in the coal fields at least, a pronounced dendritic drainage pattern. Like the veins of an enormous leaf, from which this drainage pattern gets its name, countless small streams form an intricate pattern of valleys in the sandstones and shales of the dissected plateau. This complex interfingering of streams has, no doubt, contributed to a lively history of stream piracy, which, in turn, must have accelerated the dissection of the plateau.

The drainage pattern in Powell Valley is typical of that seen often in the Valley and Ridge Physiographic Province. This consists of rather straight main streams parallel to the ridges, fed by

This map illustrates the extensive network of waterways within the Pound River National Park region. The main river, the Pound River, flows from the north towards the south, with several major forks and tributaries. To the west, the Roaring Fork and Upper Powell River join the main river. Further west, the Guest River and Bear Creek are prominent. The southern section of the map shows the Middle and Lower Guest Rivers, along with Bull Run and Russell Creek. To the east, the Pound River South Fork and North Fork are shown, along with the Indian, Bowle, Sambo, and Birchfield creeks. The map also depicts the surrounding landscape, including the Appalachian Mountains and various towns and landmarks like Big Stone Gap and the Pigeon and Looney Creeks. A north arrow is positioned in the bottom right corner.



numerous smaller streams which descend from the ridges, meeting the larger streams at right angles.

The northern part of Wise County is drained by the Pound River, which is fed by its North and South Forks and Indian Creek. Birchfield Creek and the Cranesnest River also exit the northern part of the county, to join the Pound River in adjacent Dickenson County.

The southeast and central portions of the county drain to the Clinch River, largely via the Guest River. The county's western portion is drained by the Powell River, which breaches Little Stone Mountain at Big Stone Gap, and is fed by Pigeon and Looney Creeks, Callahan Creek, Roaring Fork and Black Creek.

The Clinch and Powell Basins feed southwesterly, first to join the Tennessee River, and eventually, the Ohio River. The north easterly flowing waters of the Pound River also wind up in the Ohio, but they find their way there through the Big Sandy, which they join in Kentucky.

The steep-walled valleys and shallow soil cover allow rainwater to run off quickly, allowing little to soak into the water table. Not only does such a situation pose the threat of flash flooding, but it effectively restricts the steady flow of all but the largest streams. Consequently, many streams go dry during times of little precipitation. Since a stream is often the reflection of the water table in a topographically low area, this "drying up" indicates the lowering of the water table. During times of little precipitation,

this lowering often affects users of ground water, especially those with the shallower wells.

Drainage - Dickenson County

Dickenson County is drained by two major river basins, the Clinch and Russell Fork (Plate 2). The Russell Fork, which flows northeasterly, merging with the Big Sandy, is fed mainly by the Pound, Cranesnest and McClure Rivers. In the north-central portion of the County, the Pound is dammed, forming the John W. Flannagan Reservoir, which is used as a source of drinking water, for flood control and for recreation.

South of Sandy Ridge the waters of Dickenson County drain to the Clinch River, which eventually flows into the Tennessee River.

The drainage pattern is almost universally dendritic, with one startling exception: Russell Fork flows northerly in an exceptionally straight manner. The reason for this is immediately understood when one looks at the Geologic Map of Dickenson County (Plate 6), for the river follows the path of the Russell Fork Fault, which runs north-northwesterly from the St. Clair Fault near Big A Mountain to the Kentucky border, where it forms the north-eastern terminus of the Pine Mountain Fault.

As in the case of Wise County, the narrow valleys and shallow soil of Dickenson County permit rain water to run off quickly, giving rise to the threat of flash flooding during times of intense precipitation. In times of prolonged dry weather, all but the largest streams cease to flow, and their output is reduced to a trickle.

Climate

The general climate in Wise and Dickenson Counties is classified as warm temperate, or more specifically, humid subtropical. The main climatological influences are latitude, topography and the prevailing winds.

The average annual precipitation in the area is approximately 47 inches (119 cm) and the average annual temperature is 53 degrees Fahrenheit (11.7° C). The annual snowfall average is 18 inches (46 cm), which is equivalent to 1.5 inches (3.8 cm) of rainfall. As shown on Plate 4, which can be interpreted as reflecting conditions throughout the study area, most precipitation occurs in early to mid-summer, with the autumn being dryest.

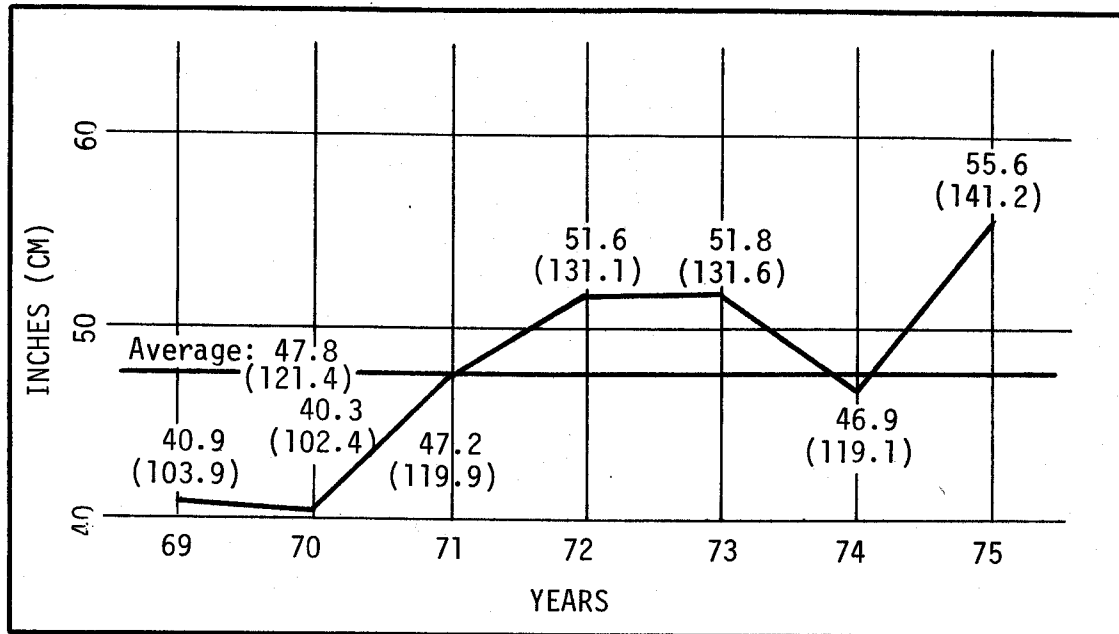
Soils

There are essentially three types of soil in the study area. They are: residual soils, alluvium and colluvium. A residual soil is an in-place soil that has been formed as a result of weathering of its parent rock. Alluvium is a soil that has been transported by water, and colluvium is a soil that has been transported physically by gravity from a higher elevation. Many areas contain mixtures of two, or even all three types of soil.

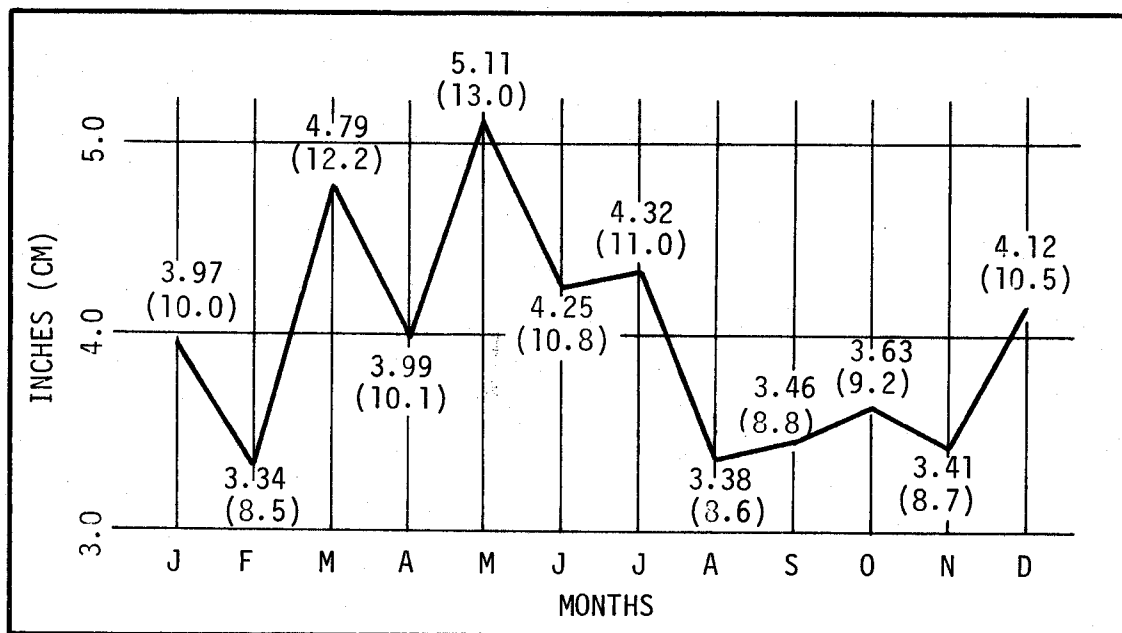
Most of the study area contains silty sands. In Powell Valley, however, the limestones and dolomites weather to a thick, clayey soil that is quite fertile.

Alluvial cones have built up in the mouths of many valleys and ravines. In Wise County, at the mouth of Crackerneck Hollow, a fan of gravel is spread out for nearly one-half mile (0.8 km). The

PRECIPITATION IN WISE-DICKENSON COUNTIES



PRECIPITATION IN INCHES (CM) PER YEAR IN WISE-DICKENSON COUNTIES



PRECIPITATION IN INCHES (CM) PER MONTH IN WISE-DICKENSON COUNTIES

Source: National Oceanic and Atmospheric Administration

PLATE NO. 4

mouths of the ravines in Stone and Little Stone Mountains have smaller, steeper cones. In Big Stone Gap, a gravel terrace 20 feet (6.1 m) above the present stream provides evidence of a higher stream bed in the past.

Outside of the Valley and Ridge formations in Powell Valley the best soils are found on the most gentle slopes, where the effects of erosion are least. These include areas in the vicinity of Sandy Ridge and Flatwoods.

In many of the valleys the soils that cling to the valley walls are only a shallow, stony, sandy loam lying immediately above slightly-weathered, resistant bedrock. The removal of lumber, and strip mining operations, have in many areas accelerated erosion to such an extent that little, if any, vegetation can flourish.

Vegetation

The vegetation along the ridges throughout the study area often is stunted due to the thin soil's poor water-bearing ability, and the effects of harsh winds. Nevertheless, numerous small chestnuts and oaks cling tenaciously to even the steepest slopes. The mountain slopes are home to more than half of the forested area in Wise and Dickenson Counties, with white oak being the most abundant, particularly on the northern slopes where evaporation is less. Other slope-dwelling trees include yellow poplar, hemlock, white ash and maple, which become more abundant at the lower elevations. The forests as a rule have only modest underbrush.

Numerous denuded areas in the coal fields caused by some strip mining operations provide mute stark testimony to the fact that vegetation can only be reintroduced by careful planning and management.

CHAPTER III

HYDROGEOLOGY

Introduction

The relationships between geology, topography and hydrology are intimate, complex and often quite subtle. It is the purpose of this chapter to give a brief geologic history, list the stratigraphy, and discuss the major geologic structures and how they relate to the hydrologic cycle and ground water.

Geologic History

All of the rocks in the Wise-Dickenson study area are sedimentary, formed from waterborne sediments that were deposited in a large trough which, at the time of deposition, extended from present-day Alabama to at least Newfoundland. During the time of deposition (Paleozoic Era) the land level and sea level shifted relative to each other countless times.

During those times in which the land was high relative to the sea, erosion was more intense, carrying clastic, sand-size particles into the wide trough or geosyncline, later to be consolidated into sandstones. Shales and clay stones were formed in the same manner from silts and clays which were brought in during times when the land was relatively low. Often when this geosynclinal sea was shallow there were periods of intensive animal life, and the limestones and dolomites that presently underlie the area were formed from limy muds that were enriched by the calcareous shells of dead animals.

At the end of the Paleozoic Era forces of enormous magnitude began exerting pressure against the geosyncline from the southeast.

Eventually, the nearly flat rocks at the bottom of the geosyncline began to buckle and fold between the vice-like jaws of the land mass to the west and forces of compression from the southeast. Breaks began to appear in the rocks, and large masses of rocks were forced over one another in a series of major northeast-southwest-trending thrust faults.

The rocks of the Cumberland Plateau were stronger than the shales and limestones of the Valley and Ridge, so the amount of folding and faulting is much less there, although some folds and faults are present. However, the rocks of the Plateau generally have maintained their nearly flat character. Further to the east the faulted, up-turned and occasionally overturned, softer rocks of the Valley and Ridge began eroding. The harder sandstone and conglomerate beds began to form the spines of ridges as the less resistant rocks began to weather away at a rate much faster than that of the ridge-formers. Today, these resistant rocks cap the mountains of the Valley and Ridge, and the shales and limestones form the valleys.

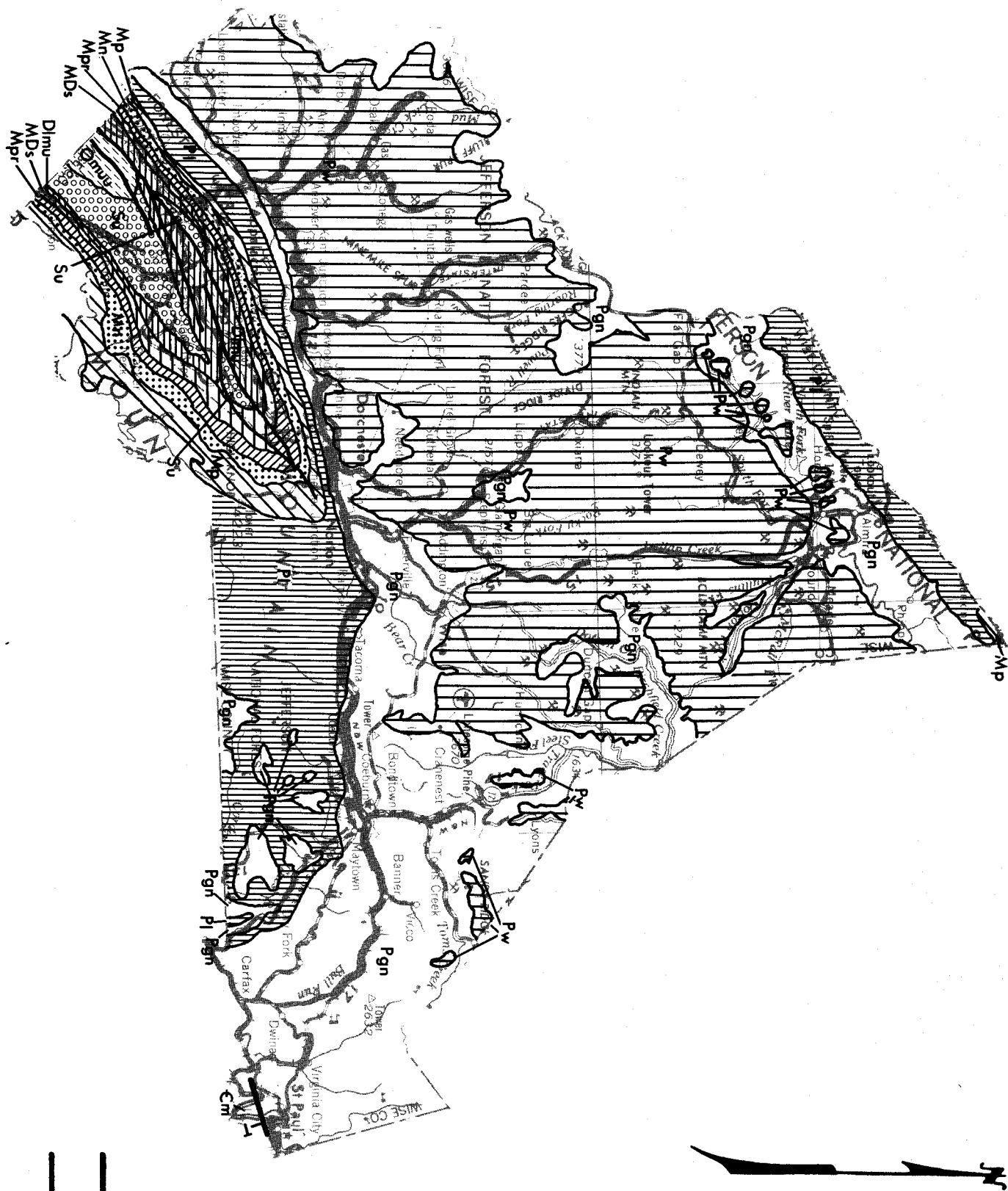
This process of deposition began approximately 500 million years ago, and it continued for nearly 300 million years, whereupon the process of folding and faulting was begun, subsequently followed by erosion.

Stratigraphy

Cambrian (Earliest Paleozoic)

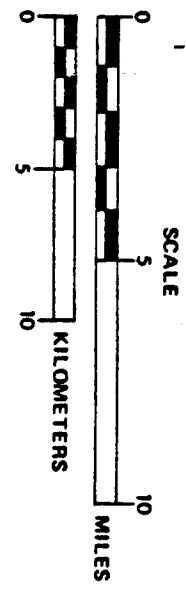
Maysville Limestone. This Conasagua age formation crops out in the vicinity of St. Paul where it takes the form of a dark blue-gray, thick-bedded magnesian limestone. It is terminated slightly north of St. Paul where the St. Paul Fault places it in contact with the much

GENERALIZED GEOLOGIC MAP OF WISE COUNTY



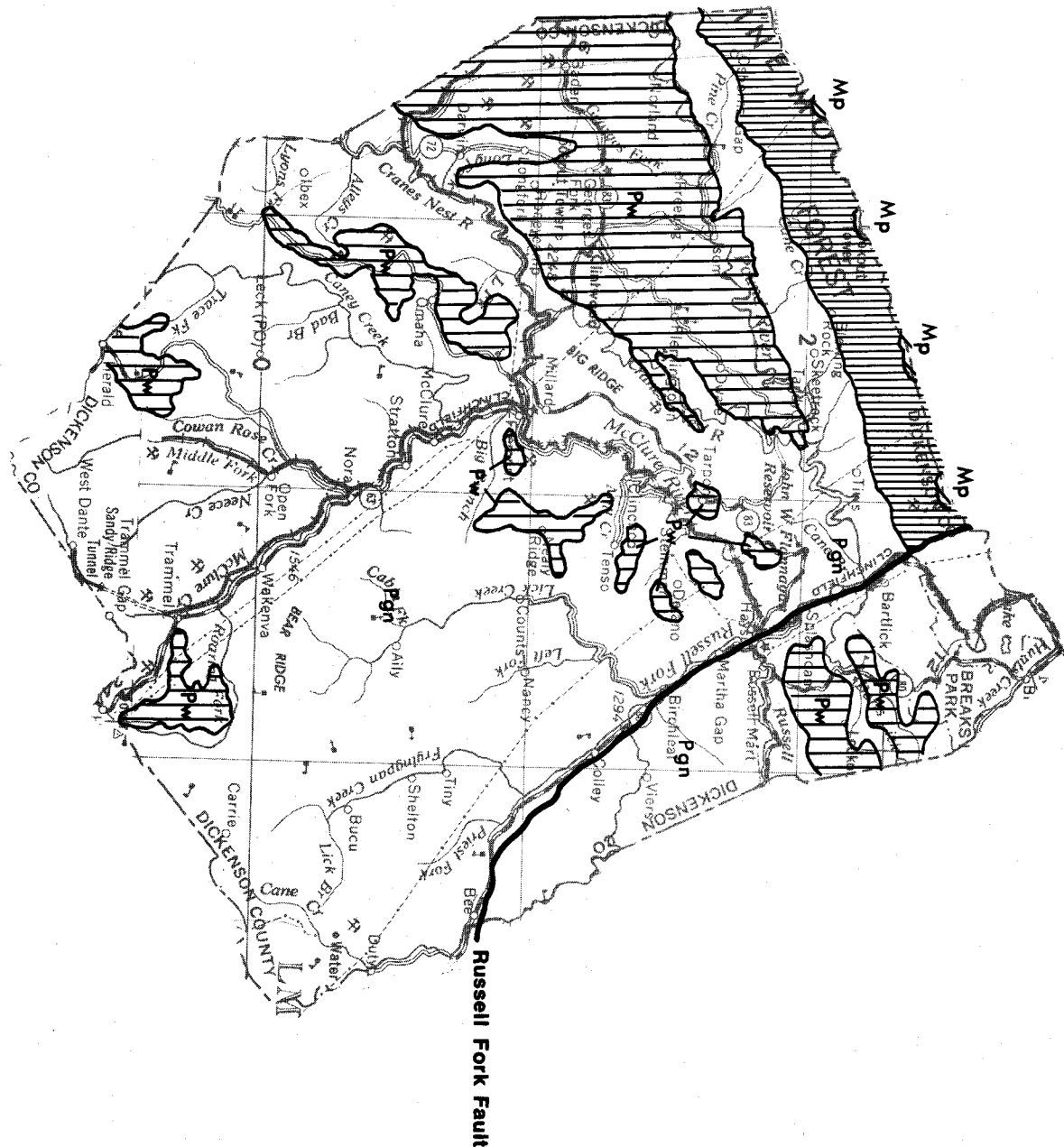
EXPLANATION

MISSISSIPPIAN			PENNSYLVANIAN		
	Maccrady-Price Formation			Wise Formation	
	Mississippiian-Devonian Shales			Norton-Gladeville Group	
	Lower to Middle Devonian Undivided			Lee Formation	
	Silurian Undivided			Pennington Group	
	Middle to Upper Ordovician Undivided			Newman Limestone	
	Cambrian Maysville Limestone				



- SYMBOLS**
- Fault
 - Thrust
 - Thrust side
 - T-overthrust side
 - Geologic Boundaries

GENERALIZED GEOLOGIC MAP OF DICKENSON COUNTY



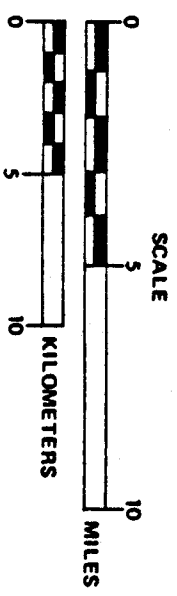
SYMBOLS

Fault

Geologic Boundaries

EXPLANATION

MISSISSIPPIAN		PENNSYLVANIAN	
	Pennington Group		Wise Formation
	Lee Formation		Norton-Gladville Group



younger, Pennsylvanian age Lee formation. Its thickness in this area is estimated to be between 500 and 600 feet (152.4 and 182.9 m) thick. It is a good-to-fair aquifer, providing water that is usually slightly hard. Near the St. Paul Fault, the broken nature of the rock makes it more permeable, but also more vulnerable to contamination.

Ordovician

For this report, these rocks have been combined into one group, the Middle and Upper Ordovician Undivided (Omuu). However, they consist of the Lowville limestone, the Eggleston limestone, the Martinsburg (subdivided into the Trenton limestone and the Reedsville shale) formation, and the Sequatchie formation.

Lowville Limestone. The Lowville limestone is a thin-bedded, fine-grained, drab to light reddish limestone with some argillaceous beds that weather to a buff-brown. It crops out sparingly along the axis of greatest uplift along the Powell Valley Anticline.

Eggleston Limestone. The Eggleston limestone overlies the Lowville. It consists of an impure, shaly limestone with interbeds of purer, blue-gray limestone. It is exposed only in Williams Cove on the lower slope, and on spurs of Wallen Ridge.

Trenton Limestone (Lower Martinsburg). The Trenton limestone is a highly fossiliferous, medium-gray limestone that overlies the Eggleston. The upper beds are nodular, and the lower beds are moderately thick. Some shaly interbeds are within the Trenton. It forms the middle slopes and the tops of ridges of Wallen Ridge. The Lowville, Eggleston and Trenton are good aquifers, but the water is slightly hard, and slightly irony in the shaly beds.

Reedsville Shale (Upper Martinsburg). The Reedsville shale is

poorly exposed in Wise County due to the fact that it is covered by debris from harder formations which lie above it. The formation is composed largely of a gray to yellow crumbly shale with interbeds of clayey sandstone. The top portion consists of a fossiliferous, sandy limestone that weathers to a buff, earthy sandstone. It forms the lower part of the steep western slopes of Wallen Ridge from the Lee County line north for a distance of 2-1/2 miles (4 km), where it swings around the northeast end of Williams Cove to the slopes of the foothills on the west side of the cove. It is also exposed in places along the low gap in the mountain south of Elk Knob. The Reedsville is a fair aquifer due to the fine-grained nature of its beds and its elevation.

Sequatchie Formation. The Sequatchie is a soft red sandstone that overlies the Reedsville shale and directly underlies the cliff-making and ridge-forming Clinch sandstone. It is easily eroded due to the fact that it is slightly calcareous, and crumbles readily upon weathering. It occupies the upper steep slope and the base of the westward facing escarpment at the top of Wallen Ridge. Its outcrops are mostly concealed by the talus of the above-lying Clinch sandstone, which forms the escarpment. It is composed chiefly of soft, red, calcareous sandstone and sandy shale with a reddish, greenish and buff argillaceous, sandy limestone at the base. The Sequatchie forms some of the spurs on the northwest flank of Elk Knob, and it also forms the east slope of River Ridge and other foothill ridges and spur knobs west of Williams Cove. Few wells are in the Sequatchie due to its elevation, but wells that have been drilled in it are irony, and have low yields.

Silurian System

For the purpose of this report, the Silurian System is combined into one group, the Silurian Undivided (Su). However, the formations consist of the Clinch sandstone, the Clinton formation and the Cayuga limestone. The Cayuga is subdivided into the Willis Creek and Tonoloway formations.

Clinch Sandstone. The Clinch sandstone in the Wise-Dickenson study area consists of alternate beds of quartzite and shale. The quartzite beds are generally thin, approximately 3 to 6 inches (7.6 to 15.2 cm) thick, but they can be as much as 8 feet (2.4 m) thick. They are very hard, with the colors mostly white, and occasionally bluish and greenish. The quartzite beds are highly weather resistant, and they seldom disintegrate or become porous on their exposed surfaces. Instead, they form a rust-like stain on the surface which penetrates only very slightly into the rock matrix. By contrast, the interbedded shale weathers to a soft, crumbly, reddish and greenish, clayey shale.

The Clinch caps Wallen Ridge and also forms the crest of River Ridge and other foothill ridges to the west. It also forms the west-facing escarpment at the crest of Wallen Ridge. It then appears on the east side of the mountain in two rocky spurs flanking Wildcat Hollow. It forms the tops of linear foothill knobs and low ridges west of Wallen Ridge. A massive bed of vitreous quartzite at the south end of the Town of Big Stone Gap is thought to be the upper portion of the Clinch, where it is believed to dip beneath the Clinton formation to the west. Here it is faulted against the Helderberg limestone to the east. Thick beds of the Clinch appear within the Clinton formation in the valley of Butcher Creek, where it has been

brought to the surface on the axis of a minor anticline.

Clinton Formation. The Clinton is composed of reddish, iron-rich sandstone and shale. It is the most widespread pre-Pennsylvanian age formation exposed in Wise County. It is best exposed on the eastern dip slope of Wallen Ridge, where the upper sandstone forms the sloping face, with many ravines eroded in it. A considerable area of the formation underlies the flats in and about the Town of Big Stone Gap, but few exposures can be seen there because of the thick cover of gravel and soil. Another large area of the Clinton forms the hills north of the road to Norton 3 to 5 miles (4.8 to 8.1 km) east of the Town of Big Stone Gap, where its beds are exposed by Butcher Creek. The Clinton and Clinch formations are fair-to-poor aquifers due to their massive and recemented nature. Yields are greatest near the larger streams and rivers, and where faulting and jointing have provided openings in which water can both move and be stored.

Cayuga Limestone (Willis Creek and Tonoloway). In Wise County, the Cayuga formation is composed of the Willis Creek and Tonoloway formations, where it is largely a thin-bedded, finely laminated, magnesian limestone with some thicker dolomite beds, which lie between the Clinton below, and the cherty Helderberg limestone above. This formation is exposed in many locations in Powell Valley, especially in and east of East Stone Gap where many of the hills are capped by the harder sandstone beds of the Helderberg, and on the steep slopes where the nearly horizontal Cayuga limestone crops out.

Most of the beds, upon weathering, break into thin slabs and plates. Many of the thicker beds show a brecciated or conglomeritic structure.

The basal bed of the Cayuga can be seen in the North Fork of the Powell River in the Town of Big Stone Gap. The upper part of the formation is well exposed on the road east of East Stone Gap, where thick beds of sandstone and limestone crop out at road level. Wells in the Cayuga have fair-to-good yields, but the water is usually hard.

Devonian System (Middle Paleozoic)

For this report, the Devonian is divided into the following Devonian formations: Lower and Middle Devonian Undivided (Dlmu), which consist of the Helderberg limestone, the Onondaga formation and the Millboro shale; and Mississippian-Devonian shales (MDs), which consist of the Brallier shale.

Helderberg Limestone. The Helderberg is a thick-bedded, siliceous and cherty blue limestone which overlies the thin-bedded, light gray Cayuga limestone. It weathers to a highly fossiliferous, porous sandstone and forms hard cherty masses in a clay soil matrix. The thickness varies from 40 (12.2 m) to 135 (41.2 m) feet thick. It thins southwestward down the Powell River, and near the Lee County line it is only 38 feet (11.6 m) thick.

A granular sandstone with round quartz grains is from 18 to 25 feet (5.5 to 7.6 m) above the base of the Helderberg, forming a distinctive marker bed within it. The lower sandy beds generally are well exposed, because they are resistant and cap the hills. The Helderberg is a good aquifer, especially in the thicker sections.

Onodaga Formation. The Onodaga formation is an approximately 5-foot (1.5 m) thick bed of pure quartz sandstone that lies above

the Helderberg group and below the Millboro. In Big Stone Gap it is coarse-grained, calcareous and abundant in brachiopod fossils. It probably represents a decalcified sandy limestone. The Onodaga is too thin to be considered a productive aquifer, although a well terminating in the formation may yield adequate water fed by the Millboro shale above it.

Millboro Shale. In Wise County, the Millboro shale is a black, fissile, carbonaceous, sandy shale that weathers readily, forming broad lowlands with few outcrops. It underlies the Brallier formation, but the contact is difficult to determine because the Brallier is similar in appearance, and they both are highly weathered, permitting few outcrops. It is believed to be about 200 feet (61 m) thick, and the Brallier is believed to be approximately 350 feet (106.7 m) thick in Wise County.

The Millboro is normally black with some zones of dark green, but it weathers to a light gray. It underlies much of the rolling topography surrounding Big Stone Gap.

Brallier Shale. The Brallier is a black and green, fissile shale which overlies the Millboro and underlies the Mississippian age Price formation. The Brallier is of Devonian age, but the uppermost part of those rocks thought to be Brallier may be Mississippian. For the purposes of this report, therefore, the Brallier is mapped as the Mississippian-Devonian shales (MDs).

The Brallier in Wise County is a dark gray to black, dark green, thin-bedded, fissile shale with a few thin, dark green sandstone interbeds. It is best exposed on State Route 610 on the slopes of Powell Mountain at the head of Powell Valley, and along the west

bank of the Powell River just above the Town of Big Stone Gap. In both of these locations, the Brallier is approximately 320 feet (97.6 m) thick. The Brallier and Millboro have low-to-moderate yields, and the water is irony and occasionally high in sulfates.

Mississippian System

The Mississippian rocks in Wise County consist of the Maccrady-Price formation, the Newman limestone, and the Pennington group.

Maccrady-Price Formation. The Maccrady-Price formation consists of a gray, micaceous, medium to thinly-bedded sandstone with interbeds of thin, crumbly shale, becoming much more shaly toward the top. These shale beds are red, gray and green, and represent the Maccrady shale which, due to its thinness and poor exposure due to weathering, is not mapped as a separate unit for the purpose of this report. The Maccrady-Price is estimated to be approximately 250 feet thick (76.2 m) along the Powell River, just above the Town of Big Stone Gap. The Maccrady forms the top 40 feet (12.2 m).

The Maccrady-Price is poorly exposed in most places in Wise County, because it is usually found on the lower slopes of steep mountains upheld by the resistant Lee formation, and, consequently, it is largely covered by colluvium from above. At the southeast foot of Stone and Little Stone Mountains, the Maccrady-Price is best exposed where the Powell River cuts through it above Big Stone Gap. It is also exposed east of Minton and Buffalo School.

Newman Limestone. The Newman consists of two distinct parts. The lower portion, which is approximately 400 feet (121.9 m) thick, is a massive, oolitic, cherty limestone with occasional thin beds of greenish, calcareous shale. The upper part, of approximately equal

thickness, consists of dark blue, green shales and sandstones, some of which are calcareous.

It is best exposed along the Southern Railroad cut near Big Stone Gap and along a few road cuts west of Norton. Few other sections of the Newman can be easily measured, because it crops out high up on the slopes of Stone, Little Stone and Powell Mountains, where it makes ledges, benches and cliffs between the more easily weathered formations above and below it.

Pennington Group. The Pennington group consists of the basal Pennington shale and the Bluestone formation at the top. The Bluestone consists of red clastics and a few interbeds of gray and greenish-gray mottled shales. It crops out in extreme northeastern Wise County on Pine Mountain at the Kentucky border, and similarly extends northeastward in Dickenson County. The Pennington is equivalent to the Hinton formation in West Virginia, but it will be called the Pennington in this report.

The Pennington is composed of a thick-bedded to massive sandstone at the base which changes upwards to a soft, yellow and greenish shale with some medium to thin-bedded, crumbly, argillaceous sandstone interbeds. A few beds are conglomeritic near the middle of the formation, and they are resistant enough to form hogbacks on the southeast slope of Little Stone Mountain, approximately one mile (1.6 km) north of Big Stone Gap. The Pennington forms the upper southeast slope of Stone and Little Stone Mountains, with the Lee formation forming the crests. The belt of the Pennington is wider on the southeast side of Powell Valley than the northwest side, because the dips are more gentle.

The Pennington is approximately 1,025 feet (312.4 m) thick near Big Stone Gap, and approximately 1,163 feet (354.5 m) thick in Little Stone Gap.

The Mississippian series in Wise County is seldom used as a source of ground water in Wise County because of their high elevations.

Pennsylvanian Series (Late Paleozoic)

The coal-bearing rocks of Wise and Dickenson Counties are of Pennsylvanian age, and these are from youngest to oldest: The Pocahontas formation; the Lee formation; the Norton formation; and the Harlan sandstone, all of which crop out in Wise County. The only Pennsylvanian outcrops in Dickenson County are the Lee and Wise-Gladeville formations.

Pocahontas Formation. The Pocahontas formation is a distinct formation of gray-to-light-gray, very fine to medium-grained, micaceous, feldspathic sandstones, shales, coal beds and siltstones that were previously included as part of the younger Lee formation which lies immediately above it. It underlies the southern half of both Wise and Dickenson Counties, but it thins toward the north and is absent in the northern half of both counties. Near the intersection of Dickenson, Russell and Buchanan Counties, it is approximately 500 feet (152.4 m) thick, but it thins to 350 feet (106.7 m) in eastern Wise County. This thinning continues toward the west, where it is approximately 100 feet (30.5 m) thick on the north limb of the Powell Valley Anticline, and only 30 feet (9.1 m) at Big Stone Gap. Five miles (8.1 km) northwest of Big Stone Gap it is

totally absent. The Pocahontas coal beds Nos. 1 through 7 are in this formation. In this report the Pocahontas is mapped with the Lee formation.

Lee Formation. The Lee contains three thick massive sandstone members that are conglomeritic, particularly near their bases, separated by shales and occasional thin coal beds. These three beds are highly resistant to weathering and they are the most prominent ridge formers in the Cumberland Plateau.

The basal member is nearly all quartz with numerous rounded quartz pebbles that are usually one-half to three-quarters of an inch (1.25 to 2 cm) in diameter. The purity of these beds contrasts sharply with the more arkosic sandstones of younger units. The thickness of the basal unit of the Lee formation is approximately 250 feet (76.2 m) near Little Stone Gap.

The middle resistant bed in the Lee is called the Bald Rock member, and it is approximately 160 feet (48.8 m) thick. It is separated from the basal member by a series of thin coal beds, shales and impure sandstones. It is approximately 400 to 500 feet (121.9 to 152.4 m) above the top of the basal unit.

The uppermost resistant bed in the Lee formation is referred to as the Bee Rock sandstone member. It is nearly 90 percent quartz, hard, massive fine to coarse-grained, and markedly crossbedded. It is approximately 80 to 100 feet (24.4 to 30.5 m) thick, and occasionally it is conglomeritic.

The total thickness of the Lee is approximately 1,800 feet (548.6 m) in Little Stone Gap and 1,500 feet (457.2 m) thick near Big Stone Gap. It rapidly thins to the west and northwest. The Pocahontas No.

8 coal bed lies between the basal member and the Bald Rock member, and Aily, Raven, Jawbone and Tiller coal beds lie between the Bald Rock member and the Bee Rock member in western Wise and south and central Dickenson County.

The Lee crops out throughout much of the southern portion of Wise County, and it extends northeastward along the eastern slope of Pine Mountain north of Flat Gap in Wise County through much of Dickenson County, where it is terminated by the Russell Fork Fault.

Yields from water wells in the Lee and Pocahontas formations are moderate-to-low, with the shaly members having low yields that also tend to be irony and slightly acid.

Norton Formation. The Norton lies above the Lee formation and immediately below the Wise formation. It is composed largely of shales and siltstones with some interbeds of sandstones and coal seams. The coal beds within the Norton are the Norton, Hagy, Splash Dam, the Upper and Lower Banner, and the Kennedy. The top 90 to 130 feet (27.4 to 39.6 m) of the Norton consists of the Gladeville unit which is a fairly pure quartz sandstone. It is this formation that upholds much of the plateau around the Town of Wise, but further to the north it contains more feldspars, mica and clay, and it is more easily eroded. Around Wise, the Gladeville unit provides good water, but the yields are usually low due to the relative thinness of the beds.

Where the Lee formation's Bee Rock member contacts the Norton formation, the Norton is 750 to 800 feet (228.6 to 243.8 m) thick in Wise County, and 600 to 650 feet (182.9 to 198.1 m) thick in Dickenson. However, as the top of the Lee tongues out, the Norton

becomes thicker. In eastern Wise County and in central Dickenson County, the Norton overlies the middle Bald Rock member and its thickness ranges from 1,200 to 1,300 feet (365.8 to 396.2 m) in Wise County and 1,100 to 1,200 feet (335.3 to 365.8 m) thick in Dickenson. In these areas, the Norton formation also has within it the Aily, Raven, Jawbone and Tiller Coal beds.

The Kennedy coal bed is underlain by a sandstone bed that ranges in thickness from 50 to 200 feet (15.2 to 60.1 m) thick, and forms ledges and cliffs along Pine Mountain, where it is occasionally conglomeritic. The shales of the Norton formation, which constitute approximately 75 percent of the total thickness, are gray-to-buff, slightly micaceous and commonly clayey. Water from them is moderate-to-low, and they are commonly irony and acid.

Wise Formation. The Wise formation consists of sandstones, shales and coal beds, with the sandstones accounting for approximately one-third of the total thickness. In western Wise County, it is approximately 2,300 feet (701 m) thick, but thins slightly to the northeast, where it is approximately 2,070 feet (631 m) thick. In Dickenson County, only the lower 750 feet (228.6 m) are exposed, with most exposures occurring on the upper parts of scattered ridges. Consequently, it is seldom used as an aquifer in Dickenson County. In Wise County, the Wise formation forms approximately half of the Pennsylvanian age rocks, where it crops out extensively on the slopes of Black Mountain, and in the west, central and north-central portions of the County. Water well yields are moderate, with the sandstone beds in the southern portion of the County providing the best yields.

A hard, white sandstone ranging in thickness from 20 to 50 feet (6.1 to 15.2 m) is approximately 200 feet (61 m) above the base of the Wise, and a hard, fine-grained sandstone lies about 1,000 feet (305 m) above the base in Wise County. Most of the remaining section consists of olive, gray and brown shales and sandstones, with some interbeds of claystones, some of which display varicolored laminae.

Harlan Sandstone. The Harlan is the uppermost Pennsylvanian formation in Wise County, cropping out on Black Mountain and many high spurs in northwestern Wise County. It is absent in Dickenson County. Its basal unit consists of a massive, occasionally conglomeritic sandstone ranging in thickness from 40 to 60 feet (12.2 to 18.3 m). Another very massive, pinkish, extremely hard, conglomeritic sandstone lies above the basal member. It is about 100 feet (30.5 m) thick, and it is quite prominent along Looney Ridge. The total thickness of the Harlan sandstone is approximately 880 feet (268.2 m) thick, with the best exposures descending from the crests of Black Mountain.

Quaternary System

Recent age deposition of boulders, gravels, sands, silts and clays have formed terrace and flood plain deposits throughout many valleys and along all major streams in Wise and Dickenson Counties. These unconsolidated deposits seldom accumulate to thicknesses of more than 20 feet (6.1 m) in the coal fields, and are limited in width due to the narrow, steep-walled valleys in which they are formed. In Powell Valley, broad areas of lowlands are deeply covered with stream deposits. This is true not only along the Powell River from Big Stone Gap south to the county line, but also in the valley of Beaver Dam

Creek and at the head of Butcher Creek. Water wells that are exclusively in alluvium are highly subject to contamination and loss of water during times of drought. Alluvial deposits are best used as sources of recharge to the underlying formations below them.

Structure

General. Geologic structure is important to the understanding of the geohydrology of an area, for it can provide clues as to the movement of ground water, the tilt or dip of aquifers at depth, and the fractured or broken nature of aquifers at depth. By understanding the structure, often it is possible to locate aquifers at a new location by projecting aquifers with known characteristics at a remote site to the new location. This process is complicated by minor folding and the thinning and tonguing of some beds, but in other cases it can serve as a valuable tool to predict ground water production.

Folds - Wise County

Powell Valley Anticline. The Powell Valley Anticline is a great, broad arch in the rocks that enters Wise County from the southwest part of the County and plunges northeastward. It is strongly asymmetrical, as can be illustrated by the basal conglomerate of the Lee, which dips from 60° to 90° to the northwest on Stone and Little Stone Mountains, and dips gently from 20° to 40° to the southeastern Powell Mountain.

It is the Powell Valley Anticline that is responsible for introducing the pre-Pennsylvanian rocks to the surface in Wise County. They form the floor and slopes of Powell Valley, with the younger, coal-rich rocks having been eroded away.

GENERALIZED HYDROLOGIC SECTION OF
WISE-DICKENSON COUNTIES

SYSTEM	SERIES	SYMBOL	NAME OF AQUIFER	THICKNESS IN FEET (METERS) IN WISE COUNTY	THICKNESS IN FEET (METERS) IN DICKENSON COUNTY	AQUIFER CHARACTERISTICS
QUATERNARY	RECENT	Qu	Unconsolidated Deposits	0-20 (0-6)	0-20 (0-6)	Unconsolidated deposits of boulders, sands, silts, and clays. Not used as an aquifer, but such deposits increase recharge to underlying formations.
		Pw	Wise Formation	2,300 (701) to 750 (229)	750 (229) to 600 (183)	Moderate yields of slightly acid, irony water. Southern sandstones provide higher yields in Wise County. Seldom used as an aquifer in Dickenson County due to high elevation.
PENNSYLVANIAN	MIDDLE	Pgn	Norton-Gladeville Group	1,300 (396) to 800 (244)	1,200 (366) to 650 (198)	Good quality water from Gladeville sandstone around Wise, but yields are moderate due to thinness of beds. Shales provide moderate-to-low yields of irony, acid water.
	LOWER	Pl	Lee Formation	1,800 (549) to 830 (253)	830 (253) to 500 (152)	Moderate-to-low yields from both sandstones and shales that make up this formation. Shales and coal seams often yield irony and slightly acid water. Locally sulfates may be high.
MISSISSIPPIAN	UPPER	Mp	Pennington Group	1,163 (354) to 1,025 (312)	1,025 (312) to 900 (274)	Sandstones and shales that yield low amounts of irony water. Seldom used as an aquifer due to its high elevation.
		Mn	Newman Limestone	800 (244)		Fair-to-good aquifer in lower elevations, although water may be hard. In higher elevations may be suitable for small domestic needs.
DEVONIAN		Mpr	Maccrady-Price Formation	250 (76)		Fair-to-poor aquifer. Low yields at higher elevations.
		MDs	Mississippian-Devonian Shales	550 (168)		Fair-to-poor aquifers, having low-to-moderate yields of irony water. Occasionally high in sulfates.
SILURIAN		Dlmu	Lower to Middle Devonian Undivided	350 (107)		Too thin to be productive aquifer.
		Su	Silurian Undivided	400 (122)		Good aquifer in thicker sections.
ORDOVICIAN	UPPER	Omuu	Middle and Upper Ordovician Undivided	200 (61)		Fair-to-good yields, but water often hard.
	MIDDLE			450 (137)		Fair-to-poor aquifers due to their massive nature. Yields are highest near larger streams and rivers, and where jointing and faulting exist.
CAMBRIAN		Em	Maysville Limestone	500 (152)		Poor aquifer with low yields of irony water.
				500 (152)		Fair aquifer with low yields of slightly acid water.
CAMBRIAN				375 (114)		Moderate-to-good aquifers, but water is usually slightly hard. Some iron in shaly beds, especially in the Trenton. Bacterial contamination may be a problem.
				500 (152)		Mostly hard water, locally abundant, but with a high likelihood of bacterial contamination.

Middlesboro Syncline. The Middlesboro Syncline is a broad shallow trough that extends through northern Wise County in a northeast-southwest direction. In the vicinity of Norton, it is approximately 14 miles (22.5 km) wide, and it extends for approximately 140 miles (225.3 km) from the Breaks of Sandy in Dickenson County far into Tennessee. It has been of great importance to the economy of Wise County, for it has provided a protective environment for the preservation of some of the thickest and purest coal seams in the County.

This fold, too, is asymmetrical, with the northwest limb dipping from 20° to 40° to the southeast along Pine Mountain crest, and ranging from 0° to 10° to the northeast in the trough and southwestern limb, respectively.

Gladeville Anticline. The Gladeville Anticline is the sharpest fold in the rocks in the coal fields north of Powell Mountain. It brings to the surface the resistant conglomerates of the Lee formation directly west of Wise, where it forms an elongated dome along its axis. Another similar dome is located in Indian Gap. The axis is extremely straight for a distance of approximately 12 miles (19.3 km). This has probably determined the straight course of Indian Creek, which is an unusual drainage feature for this area.

When the Gladeville Anticline branches from Powell Mountain, it is quite symmetrical, but as it extends further northward it becomes asymmetrical, with steeper dips on the western limb, and slight dips on the eastern.

Buck Knob Anticline. The Buck Knob Anticline is a north-south fold that begins at the mouth of Lick Branch of the Powell River, extending across the forks of Pound River. It, too, is asymmetrical,

with the western limb dipping much more than the eastern.

Dorchester Syncline. This fold is a northerly-trending trough that extends from Dorchester to the eastern slopes of Pine Mountain. It is asymmetrical with the eastern limb dipping from 10° to 40°, and the western limb dipping approximately 10°. Where it crosses the Middlesboro Syncline's axis, approximately 2-1/2 miles (4 km) southwest of Pound, it forms a depression of approximately 250 feet (76.2 m) deep.

Faults - Wise County.

St. Paul Fault (Hunter Valley Fault). The St. Paul Fault is one of the most extensive thrust faults in the Appalachian Region. Its total length is 370 miles (595.5 km) and has a vertical displacement of approximately 15,000 feet (4,572 m) in southeastern Wise County, where Ordovician limestones come in contact with the overturned beds of the Pennsylvanian-age Lee formation. In Wise County, it extends through the St. Paul area.

Pine Mountain Fault. The Pine Mountain Fault trace appears approximately one-half mile (0.8 km) northwest of the crest of Pine Mountain, and does not appear in Wise County, although its effect upon the geologic structure of Wise County has been profound. The St. Paul and Pine Mountain Faults represent the southeastern and northwestern boundaries of the Cumberland Block. The lifting of this block has resulted in the erosion of vast areas of coal deposits that extended southeast of the present coal fields, where they now are terminated by the St. Paul Fault.

Dip - Dickenson County

Throughout most of Dickenson County the beds dip to the northeast at a modest attitude of approximately 50 feet (15.7 m) per mile (1.61 km). A few large open folds modify this dip, as well as some areas of localized minor folding.

Folds - Dickenson County.

Middlesboro Syncline. Much of Dickenson County lies within the broad gentle limbs of the Middlesboro Syncline, which runs southwestward from Russell Fork to Tennessee. It is from 12 to 20 miles (19.3 to 32.2 km) broad, and rests between Pine Mountain on the northwest and the Sourwood Anticline at the southern portion of the county. The axis tends to follow the valley of the Pound River.

Sourwood Anticline. The axis of the Sourwood Anticline is in Russell County, but the northwestern limb extends approximately 3 miles (4.8 km) into Dickenson County, where the strata dip to the northwest and west at a rate of approximately 250 feet (76.2 m) per mile (1.61 km).

Faults - Dickenson County.

Pine Mountain Fault. The Pine Mountain Fault is terminated near the Breaks of the Big Sandy in northeastern Dickenson County where the vertical displacement is from 600 to 800 feet (182.9 to 243.8 m), and there is no evidence of overfolding. In the northwestern portion of the county, the displacement is from 5,000 to 5,300 feet (1,524 to 1,615.4 m) and is overfolded. It is believed that the reason the great Pine Mountain Fault and the ridge that is formed are terminated so abruptly in northeastern Dickenson County is due to the Russell Fork Fault.

Russell Fork Fault. The Russell Fork Fault differs from the St. Paul and Pine Mountain Thrust Faults described above in three ways. First, it is steeply dipping, with dips ranging from 75° to vertical, and secondly, it strikes to the northwest, perpendicular to the northeasterly-trending thrust faults. Also, the amount of vertical displacement is quite small when compared to the thrust faults. The vertical displacement seldom exceeds 200 to 300 feet (60.9 to 91.4 m) as compared to the 15,000 feet (4,572 m) commonly seen along the St. Paul Fault. The displacement along the Russell Fork Fault has been lateral, with the southwestern block moving toward the northwest relative to the northwestern block. The actual displacement is uncertain, but it might be as great as that of the St. Paul Fault, which is believed to be as large as 6 miles (9.7 km).

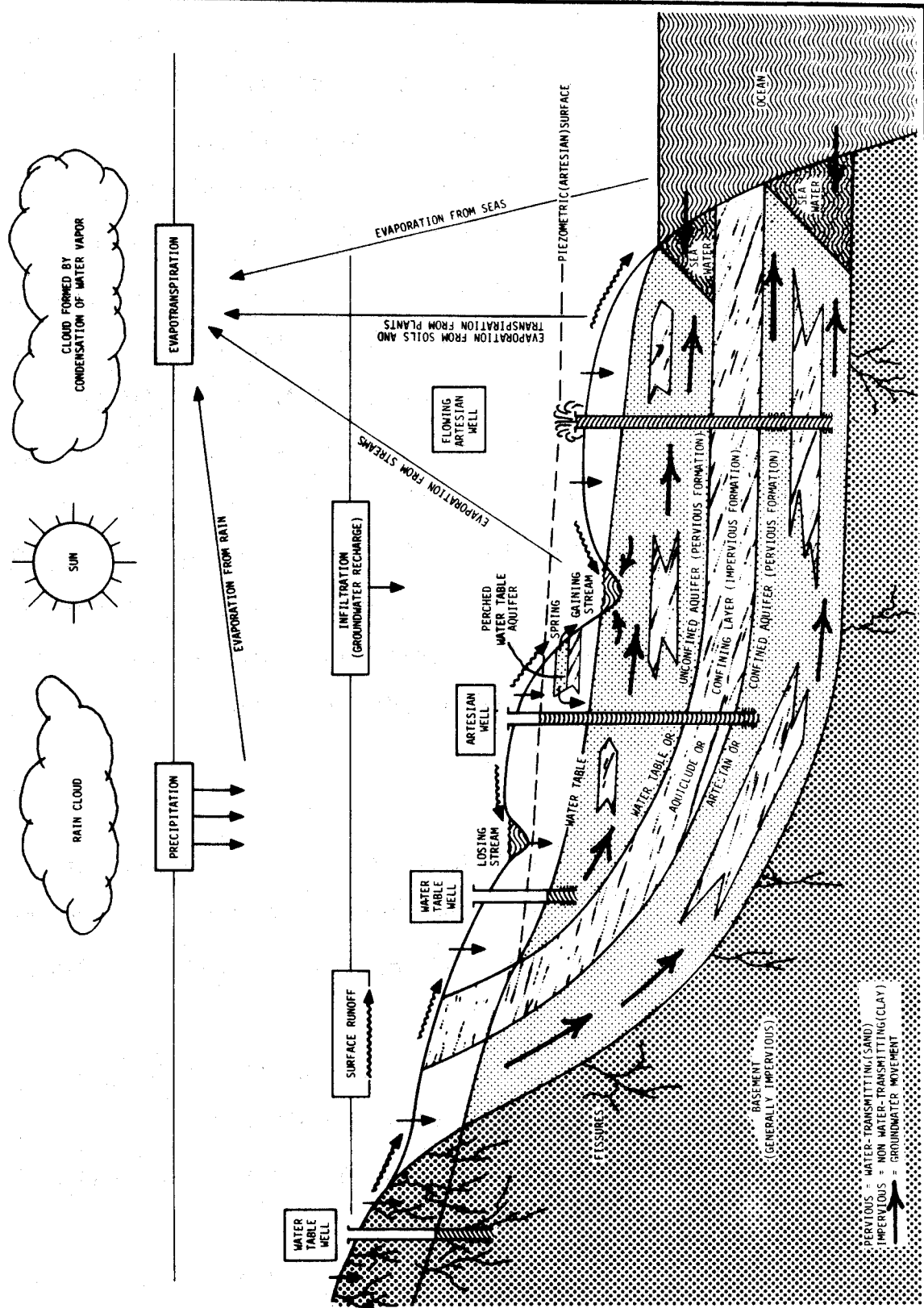
Hydrologic Cycle

The source of all ground water begins as evaporation from the seas, surface streams, ponds, lakes, rivers, plants, soils and moisture from the atmosphere. The sun draws this moisture from all of these sources. Eventually, the atmosphere can no longer contain this moisture and precipitation occurs.

Unless extreme temperature, topographic or soil conditions exist, this precipitation largely takes the form of surface runoff, quickly finding its way to streams, rivers, and lakes. Since the earth is largely covered with water, much is reintroduced directly to the seas.

Some water, however, manages to soak directly into the ground to recharge the water table. Water from streams and rivers also soaks into the ground, and it is often a major source of recharge for nearby aquifers. The route that this water takes in reaching the water

THE HYDROLOGIC CYCLE AND AQUIFERS



Source: State Water Control Board

PLATE NO. 8

table is as complex and varied as the rocks and soils through which it travels. This downward migrating water follows bedding planes, fractures, joints, solution cavities and seeps through the voids and often minute openings of the rock matrix itself.

Once the top of the water table is reached, the water has not completed its journey, because the water table, which represents the top of the water-saturated zone in an aquifer, is a dynamic environment. Water in the saturated zone flows from areas of higher topography to lower, and the water table often rises and falls due to seasonal fluctuations in precipitation. It is possible for water tables to be "perched" (see Plate No. 9). Under these conditions, ground water is trapped by a nearly impervious formation far above the regional water table. Such conditions can occur in Wise and Dickenson Counties, but the area of recharge is so small and the runoff so great that such aquifers can produce only small amounts of water before they run the risk of drying up.

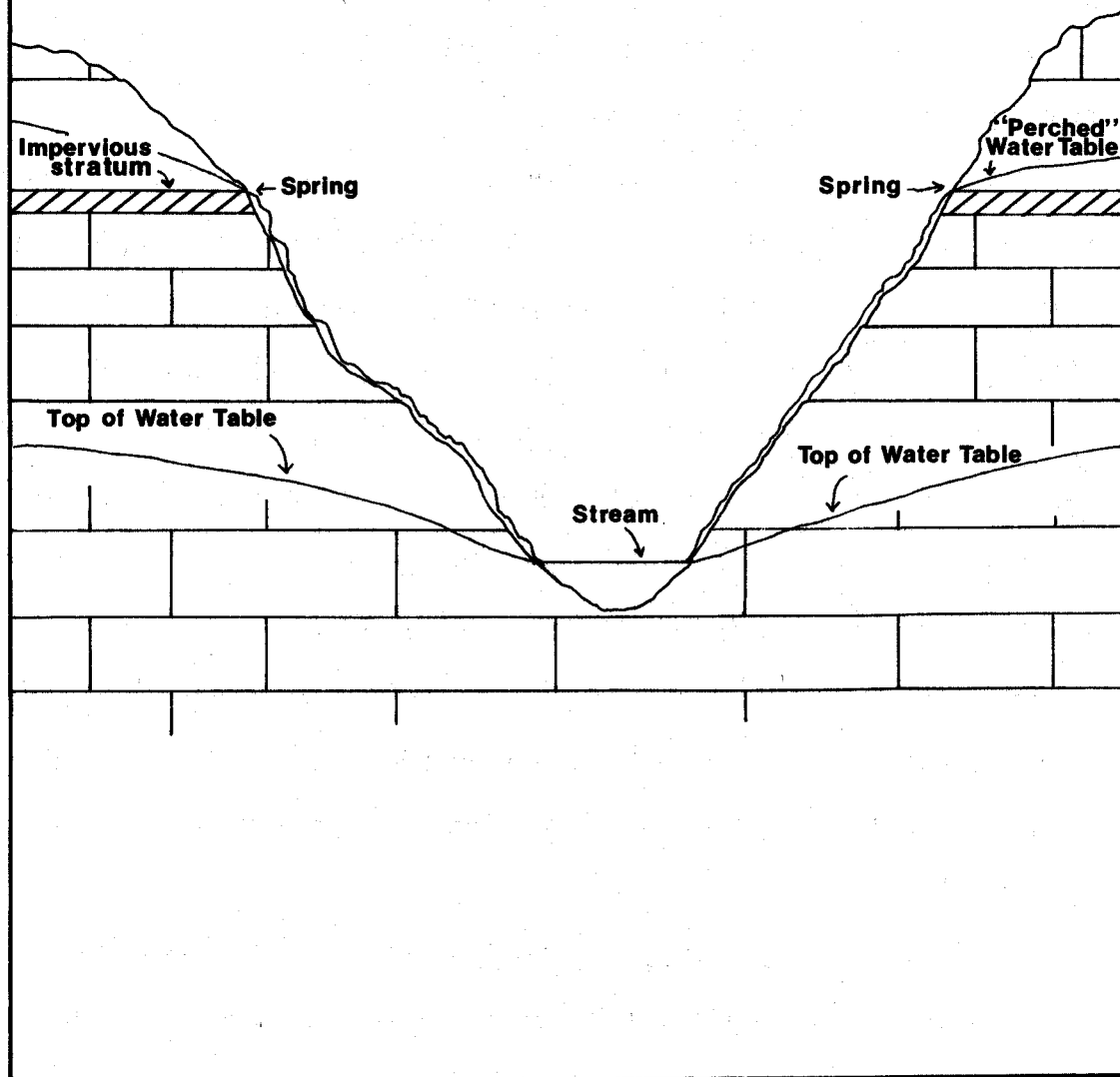
Water Well Location

General. When locating a water well, the chances of encountering an adequate supply of water are enhanced by careful consideration of the following items: aquifer characteristics, availability of recharge and topography.

Aquifer Characteristics. An aquifer, or water-bearing formation or stratum, has certain physical properties that contribute to its water-yielding properties. The two most important are porosity and permeability.

Porosity refers to the amount of open space that lies within the matrix of the aquifer. Coarse, unconsolidated deposits, such as

PERCHED WATER CONDITIONS



Source: Virginia State Water Control Board

PLATE NO. 9

gravels with little fine, intermixed material, are extremely porous, while a sandstone that has been recemented is almost impervious. Generally, the more angular the deposit grains become the more porous the deposit becomes.

The permeability of an aquifer is a measurement of the ability of water to travel through that aquifer. Generally, the more porous an aquifer becomes the more permeable it becomes. There are exceptions, however, so they must be considered together. A shale, for example, is often composed of angular, extremely fine-grained particles, and, consequently, they are often porous. The small size of the voids within the rock prevent rapid movement of water within it, and, consequently, most shales are fair to poor aquifers.

The matrix of a limestone is usually quite solid unless it has been attacked chemically, forming caves, solution cavities and voids. In this case it can often be considered the most permeable of rocks, transmitting large volumes of water long distances in a short period of time.

Fractures within a rock, caused by jointing, folding, and faulting, can greatly enhance that rock's permeability and porosity. In many cases such breaks account for most of the ability of a rock to store and transmit ground water. Often, the more brittle, quartz-rich rocks exhibit a degree of fracturing that is greater than the softer, more plastic shales. The knowledge of nearby intensive folding and faulting can, therefore, point out the likelihood of increased rock fracturing and the chance of greater yields.

Availability of Recharge. Recharge refers to the replenishment of ground water by either natural or artificial means. Artificial, or man-made, recharge is a solution to ground water depletion that

should be done under the most extreme caution, lest the entire aquifer becomes contaminated and unsuitable.

Natural recharge can be enhanced by slowing runoff by retaining vegetation on steep slopes, reducing the grade of slopes and not interfering with the normal ability of streams and rivers to feed the aquifers below.

When locating a well, the source of recharge should be a primary consideration. The availability of nearby rivers or springs to replenish the ground water is often a good sign of a productive well. If no streams are nearby, then the location of a well in a draw is advisable, because they are often formed by ancient streams and may indicate ground water flow.

Topography. Topography plays an extremely important part in well productivity in Wise and Dickenson Counties, particularly in the coal fields. It is almost a universal rule of thumb that "the lower the better." That is to say, those wells that are drilled in topographically low areas have a greater chance of being productive than wells on the higher elevations, because there is less drilling before the water table is encountered.

CHAPTER IV

GROUND WATER QUALITY

General

The best ground water in the Wise-Dickenson County area lies within the confines of Powell Valley, especially within the Middle Ordovician Limestones. The ground water from these formations does exhibit, however, some of the drawbacks common to most carbonates; namely, it is often moderately hard to hard, and it is highly susceptible to contamination. Carbonates are chemically active, reacting with rainwater containing oxides of carbon, nitrogen and sulfur that it has absorbed from the atmosphere. The result of this chemical attack is often an interconnected web of solution cavities, voids and caves. Consequently, ground water in carbonate formations often moves quickly over long distances without the natural filtration inherent in many other aquifers.

The sandstones and shales of the coal fields often have ground water that is irony, moderately hard and acid, and they may be discolored and malodorous. Bacterial contamination, as a rule, is less of a problem in this area than in the limestones and dolomites of the Powell Valley, except for shallow or poorly constructed wells. Strip mining and deep mining operations often have a deleterious effect upon both surface and ground waters in the area.

It is a general rule of thumb that ground water from depths greater than 300 feet below the valley floors is of a poorer quality than the water above that depth, due in large measure to an increase in salinity. This applies throughout the Wise-Dickenson

area, but it seems particularly true in the Cumberland Plateau Province.

A listing of chemical analyses is given in Appendices C and F.

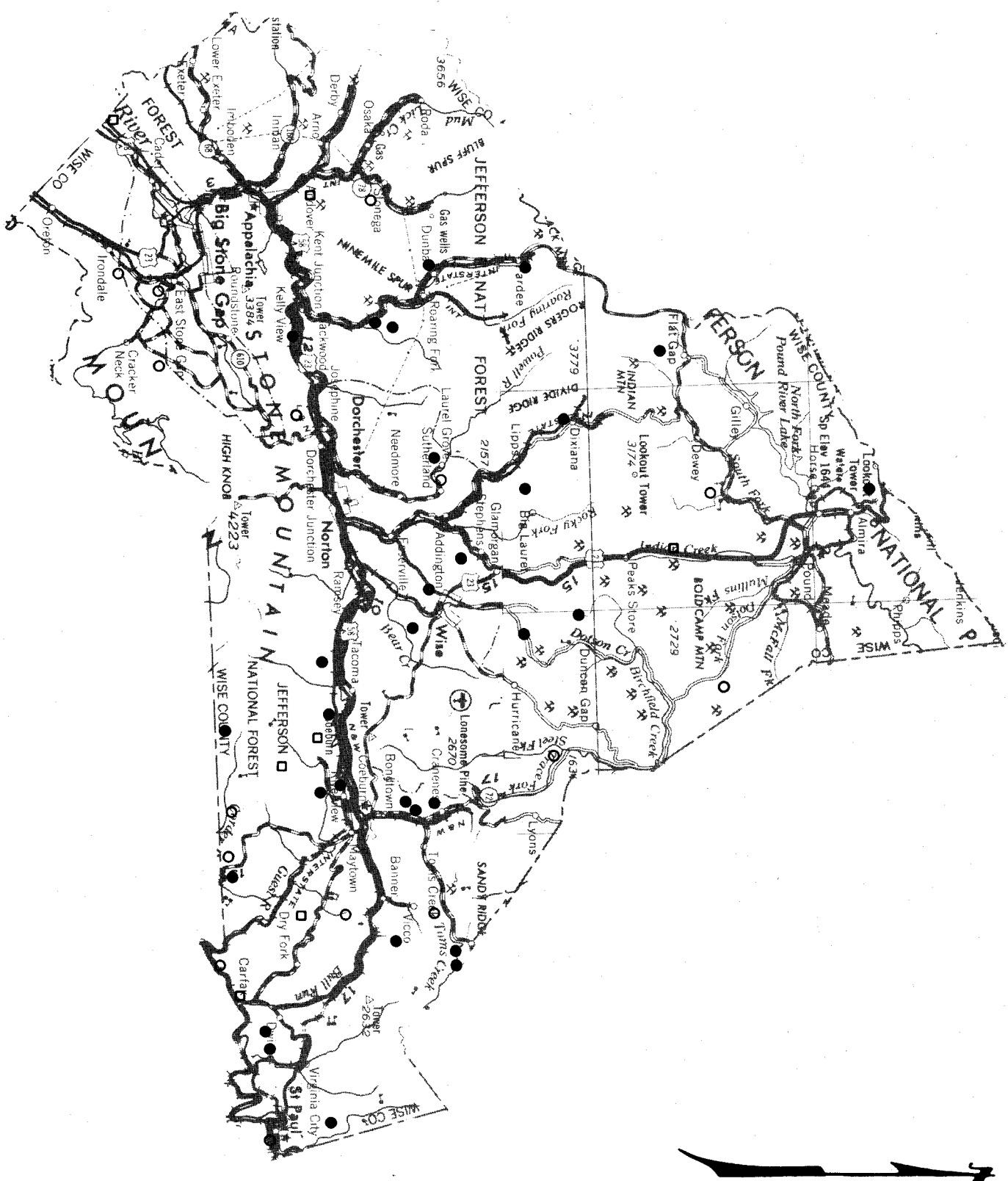
Iron

Iron is one of the earth's most abundant elements, and it is found, at least in trace amounts, in almost every rock formation. The characteristic buff, brown, yellow and reddish colors of weathered rock are often due to the oxidation of iron compounds in the rock. This phenomenon often can assist a well driller in locating the lowest depth to which the water table has dropped for an appreciable period of time. By looking at the cuttings a driller can tell when they change from the above-mentioned earthy colors to darker browns and grays. This indicates the limits of oxidation from oxygen in the atmosphere. Below the level of this color change, the constant presence of water has inhibited most oxidation.

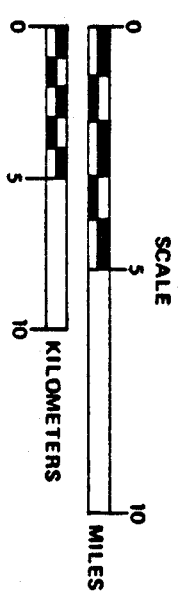
Irony water can cause the staining of clothes and porcelain, and if the concentration of iron is high enough, it can discolor the water and even leave a reddish-brown deposit after standing for a while. If the water is acid, then this problem is even more acute.

The recommended maximum limit for iron concentration as set forth by the Virginia Department of Health is 0.3 milligrams per liter. This is the concentration above which staining begins, although a slightly astringent taste can be detected with concentrations as low as 0.1 milligram per liter.

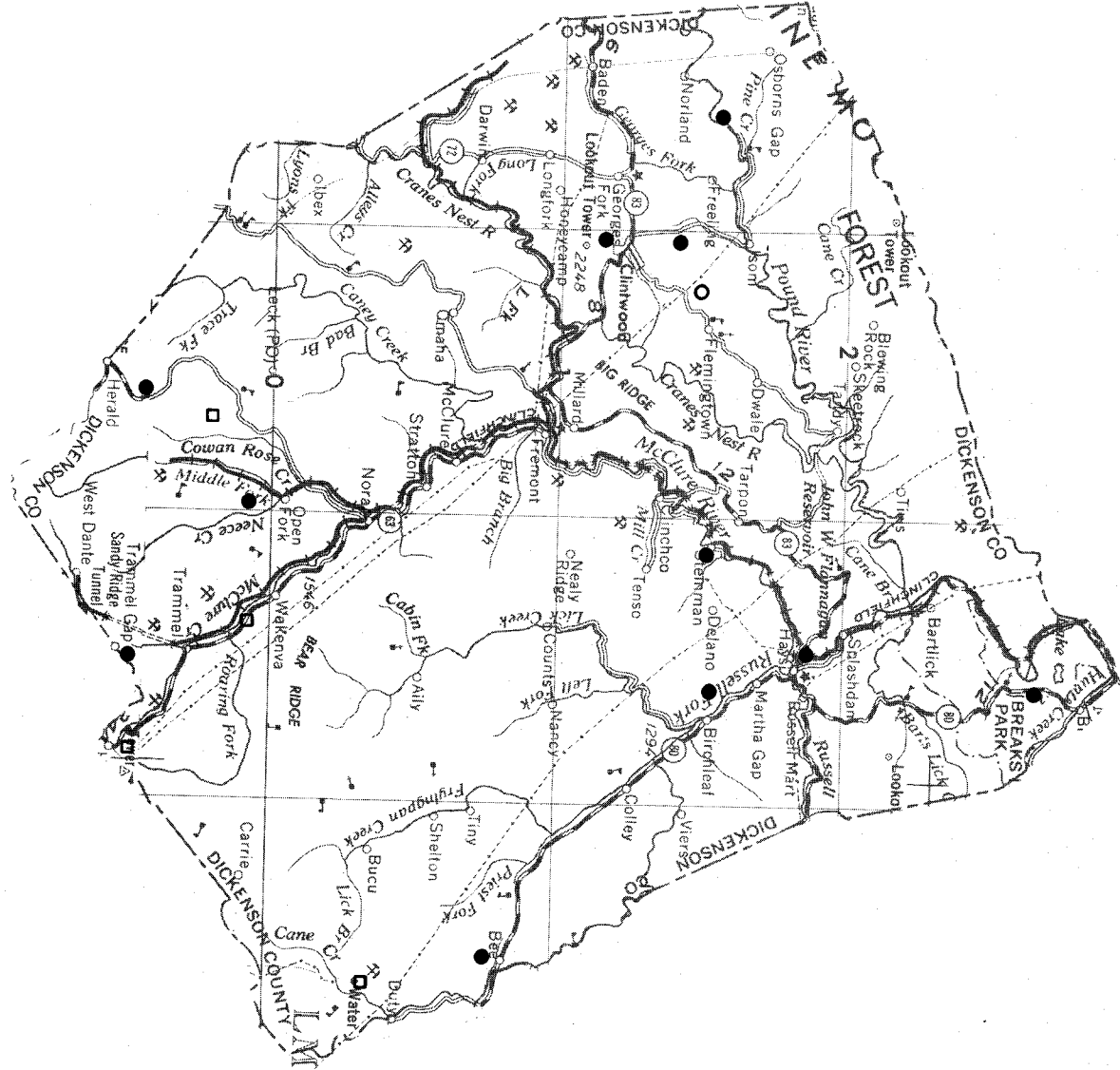
IRON IN MG/L FROM WELL SAMPLES IN WISE COUNTY



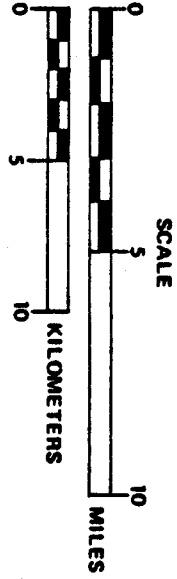
- LEGEND
- 0 - 0.29
 - 0.3-0.99
 - 1.0 +



IRON IN MG/L FROM WELL SAMPLES IN DICKENSON COUNTY



- LEGEND**
- 0-0.29
 - 0.3-0.99
 - 1.0 +



Iron concentrations can be reduced by casing off highly weathered zones where oxidation of iron compounds is great, and by also casing off coal seams where pyrite (iron sulfide) is often present and which can contribute both iron and compounds of sulfur to the ground water.

When iron becomes a serious problem the use of iron filters may be employed. However, if manganese is present, and it often is, it can quickly block up the iron filter, making it, for all intents and purposes, useless. This problem can be overcome by placing a manganese filter ahead of the iron filter. Another method for treating iron in the water is to aerate it and then filter it through a sand filter.

Sulfates

The Virginia State Department of Health has set an upper limit of 250 milligrams per liter as the maximum recommended amount of sulfates in drinking water. The oxidation of iron sulfides, which are abundant in certain coal seams, leads to the formation of ferrous and ferric sulfates, and sulfuric acid. The resulting compounds often emit a sulfurous odor and impart an extremely unpleasant taste to water which contains them. The sulfuric ion of some sulfate salts produces a laxative effect in humans, particularly among new users who have not had an opportunity to become acclimated to sulfate-rich waters. Other sulfates that may be present in the ground water are those of potassium, sodium and calcium.

Sulfates are located in ground water throughout the coal fields of the Wise-Dickenson County study area, but from the amount of data available, no discernable pattern of high sulfate ground water can be spotted. It would be safe to say, however, that those wells that penetrate high sulfur coal beds are much more likely to be richer in sulfates than those that do not. Some of the beds of shale in the coal fields have sulfates in them, but it is difficult to determine if this is inherent in the rock formations themselves, or from their close association with sulfurous coal beds.

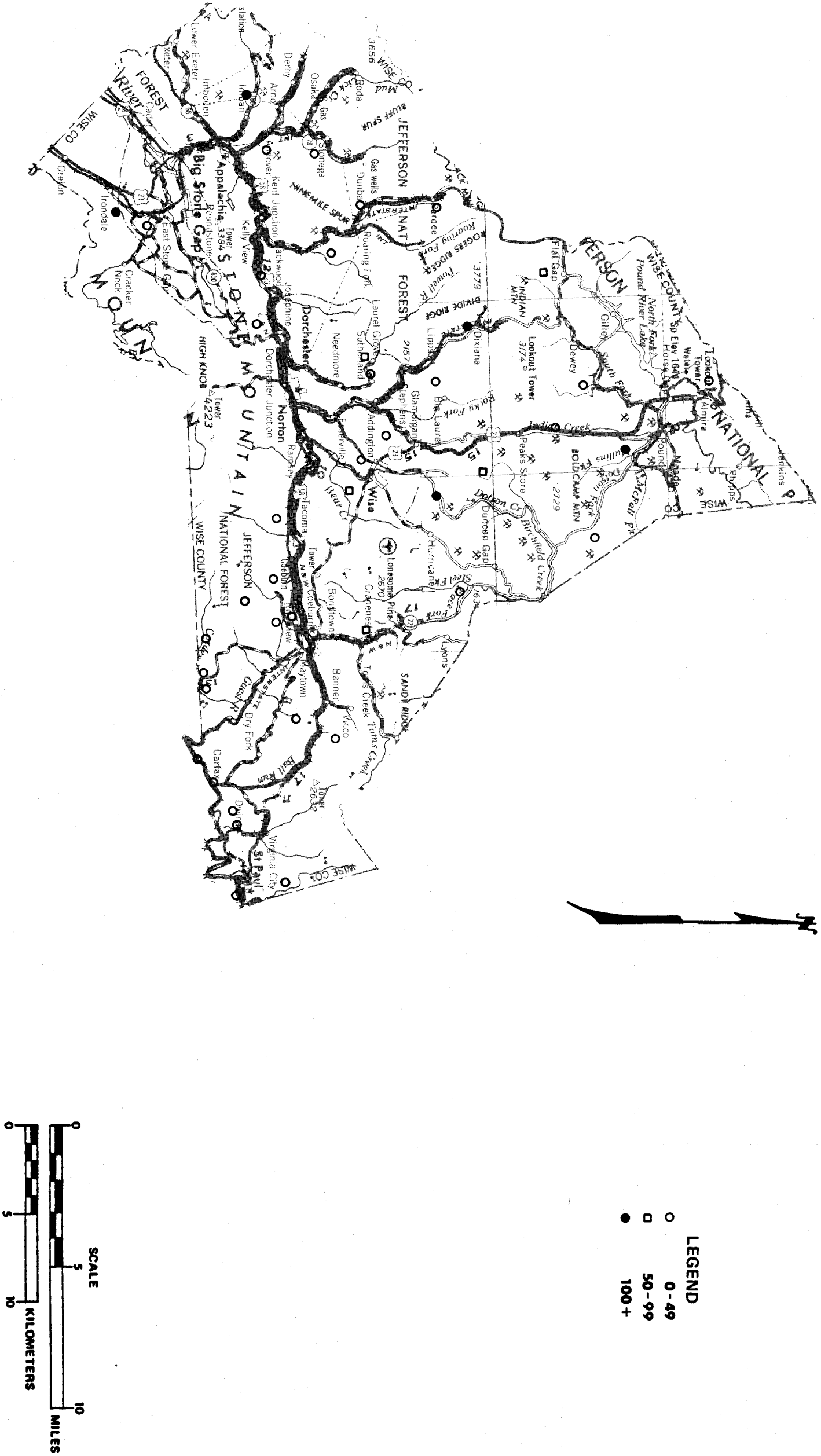
In Powell Valley, sulfates are far less of a problem than in the coal fields, but some beds of shale appear to have a higher than average sulfate content. This seems to be particularly true in the Devonian age Brallier formation (see Plate 5).

The best method to minimize sulfate problems in ground water is to case those zones that have the highest potential for sulfate contamination. Filters are available to remove sulfur compounds, and they may be the best method of treatment for existing wells with continuous sulfate problems. Water softeners have little effect in removing sulfates from drinking water.

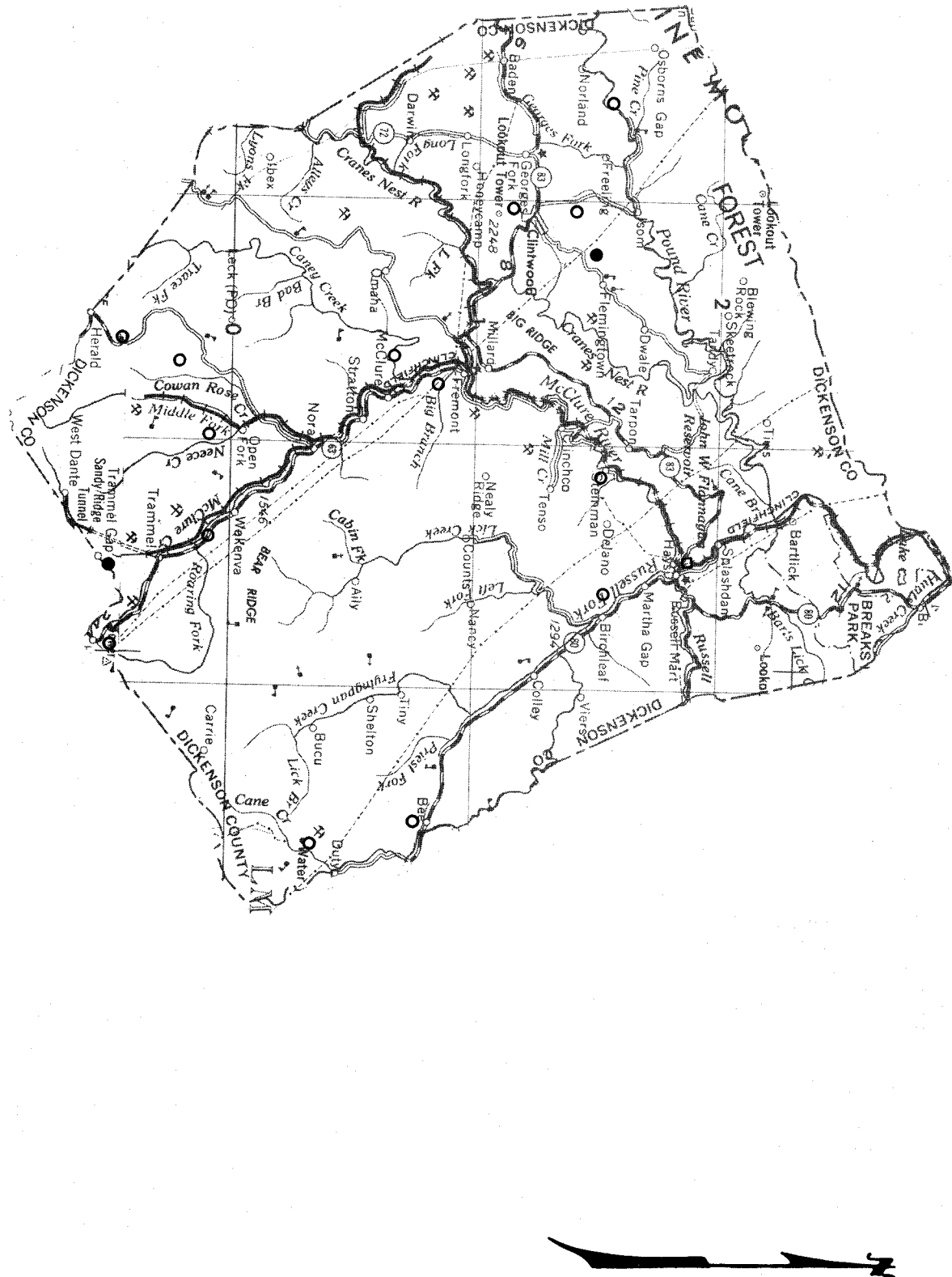
Manganese

Manganese compounds are common to many rocks and soils, where they can occur in both the divalent and trivalent forms. Manganese chlorides, sulfates and nitrates are quite water soluble, whereas the oxides, carbonates and hydroxides are only slightly soluble. In the reducing environment of ground water, manganese compounds can be leached from the overlying soil, concentrating in the ground

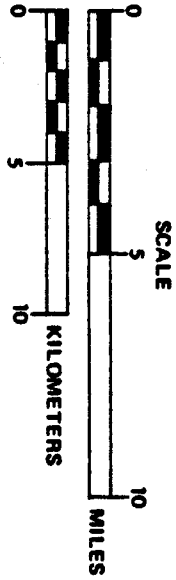
SULFATES IN MG/L FROM WELL SAMPLES IN WISE COUNTY



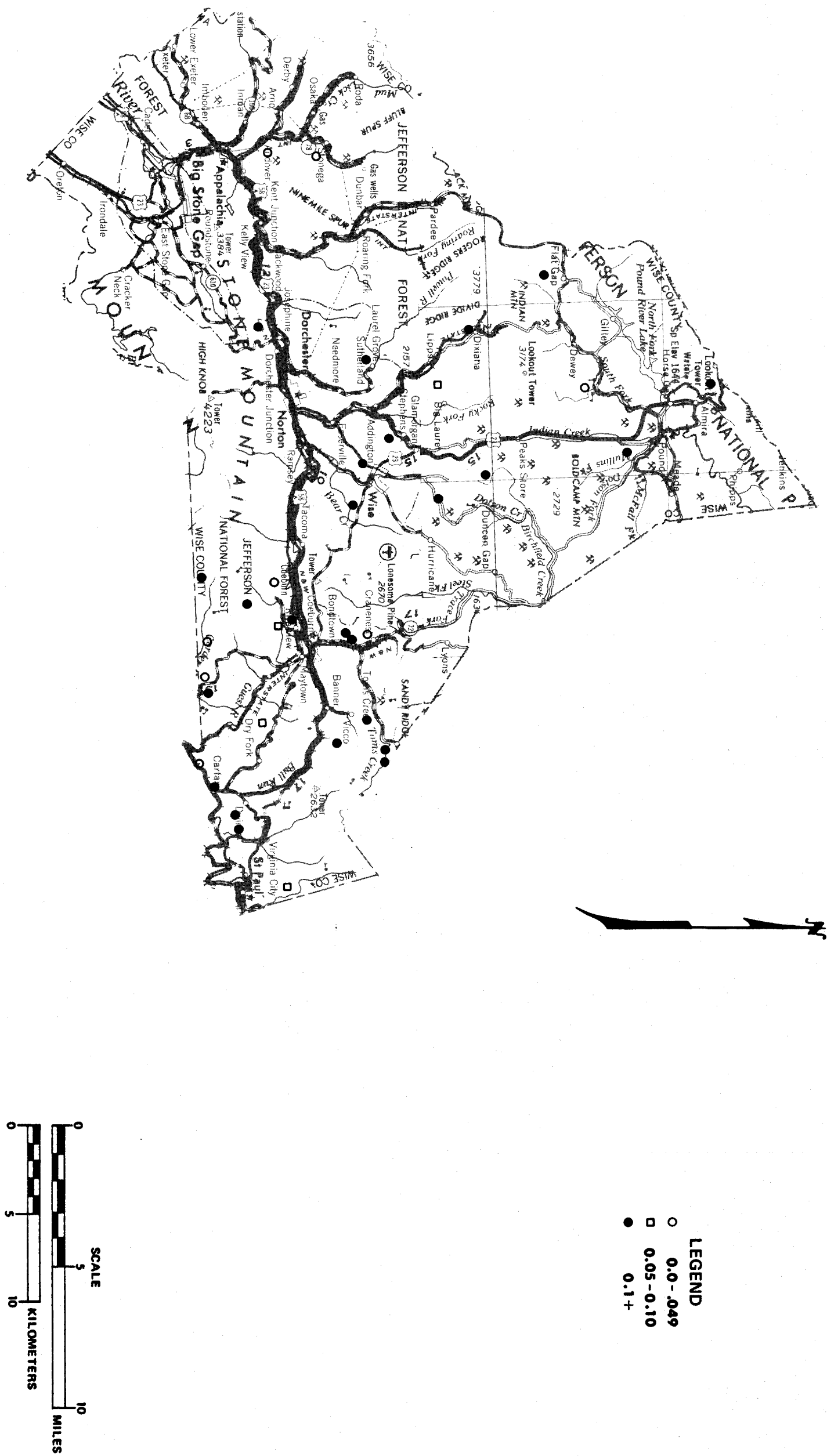
SULFATES IN MG/L FROM WELL SAMPLES IN DICKENSON COUNTY



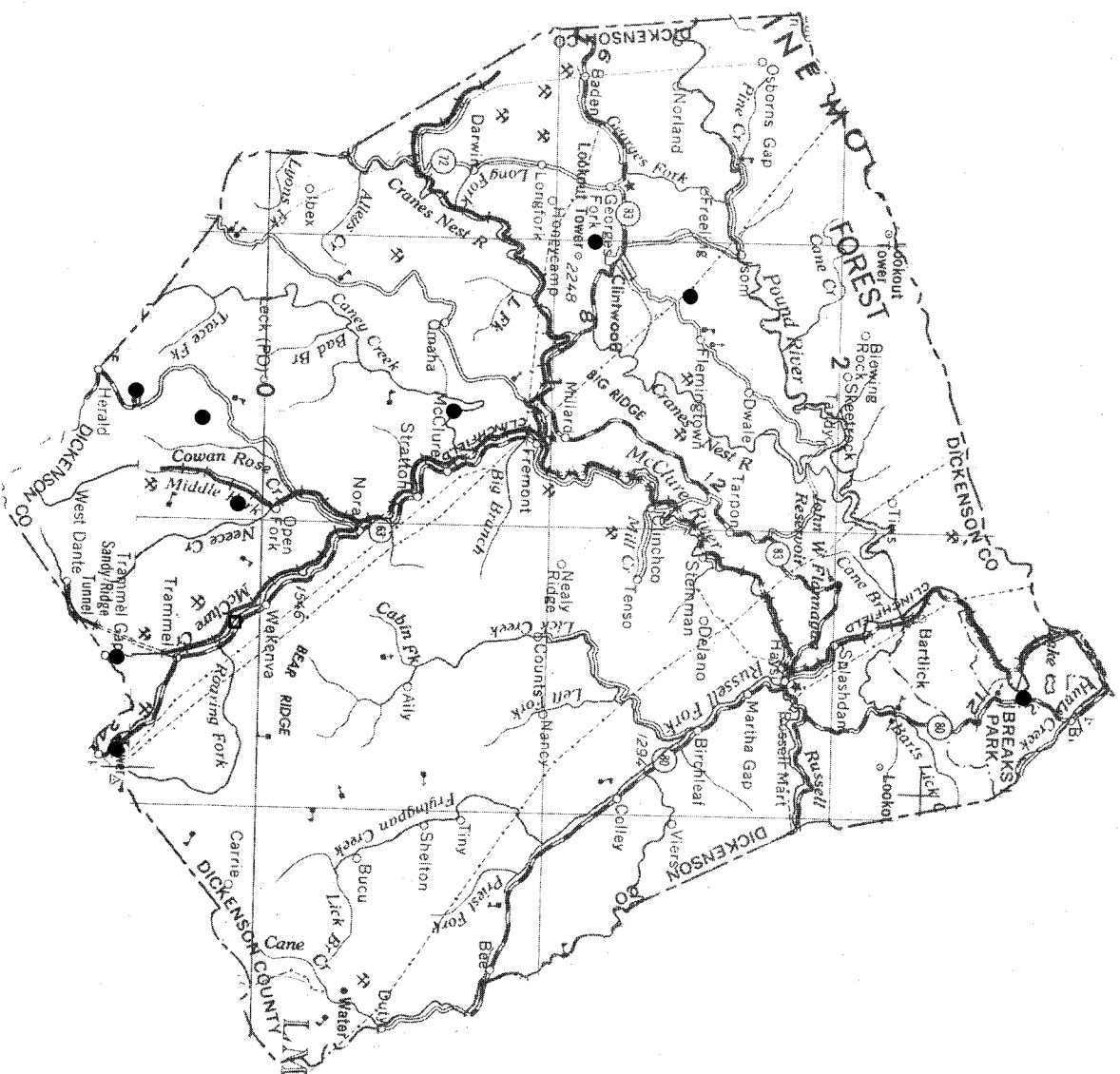
LEGEND
○ 0 - 49
□ 50 - 99
● 100 +



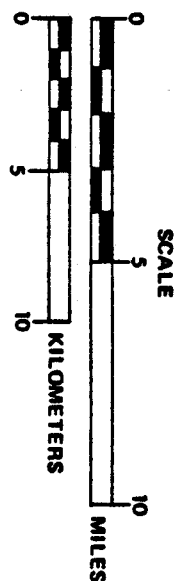
MANGANESE IN MG/L FROM WELL SAMPLES IN WISE COUNTY



MANGANESE IN MG/L FROM WELL SAMPLES IN DICKENSON COUNTY



- LEGEND**
- 0.0-0.05
 - 0.10
 - 0.10+



water. In such circumstances, the manganese is often associated with iron.

The Virginia Department of Health recommends that the concentration of manganese in drinking water not exceed 0.05 milligrams per liter. In greater amounts, the water begins to have an unpleasant taste, and it causes dark stains on plumbing fixtures and laundry.

Manganese can quickly impair iron filters, so special precautions should be used in installing ion exchange filters to ensure that either the manganese concentration is quite low, or a manganese filter precedes the iron filter. Chemical precipitation and aeration are also effective measures used in the treatment of manganese in water. Plates 14 and 15 show the concentration of manganese in Wise and Dickenson Counties, respectively.

Gases

The gases methane and hydrogen sulfide are not uncommon to the ground water in the coal fields of Wise and Dickenson Counties. Methane is believed to be a byproduct of the release of organic compounds associated with coal seams, whereas hydrogen sulfide may be formed from chemical reactions with sulfur compounds within the coal seams. They can be detected by the presence of bubbles within the water, and, in the case of hydrogen sulfide, a strong "rotten egg" smell. Due to the fact that methane is an odorless, colorless, tasteless gas which can be quite explosive, it is the more insidious of the two. In the coal fields of the Wise-Dickenson County study area, it is recommended that wells be provided with a vent to the outside of the well house as illustrated in Plate 22.

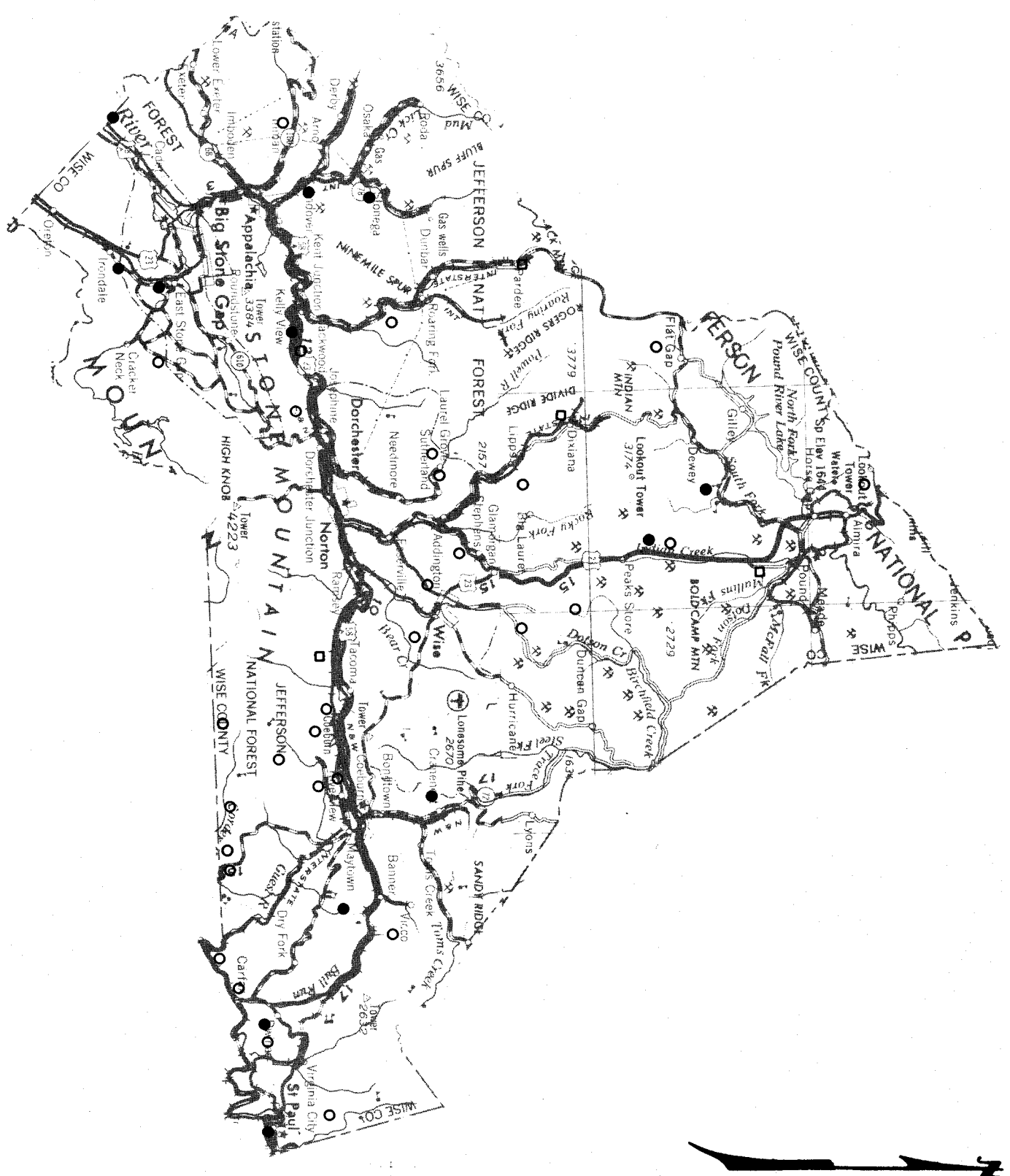
Aeration will remove the malodorous hydrogen sulfide and potentially explosive methane from ground water before they can accumulate in storage tanks and hot water heaters.

pH, Alkalinity and Corrosion

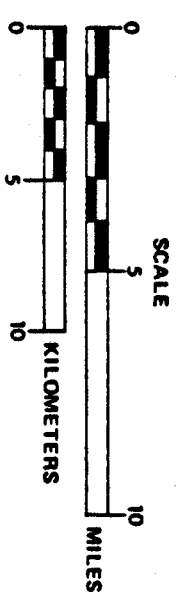
The pH of a water is measured by a scale that ranges from 0 to 14, with numbers below 7 being acid and above 7 indicating that the water is alkaline. The higher the number above 7 the more alkaline the water becomes, and conversely, the smaller the number below 7 the more acid the water becomes. The number 7 itself is neutral. In the coal fields of Wise and Dickenson Counties, most ground waters are on the acid side. The Virginia Department of Health has a secondary pollutant standard of a pH range of 6.5 to 8.5 for drinking water in the Commonwealth. This is based on aesthetic considerations, such as taste, as opposed to health considerations.

The alkalinity of water is a measurement of its ability to neutralize acids. It is due largely to the presence of carbonates, bicarbonates and hydroxides. It usually is associated with water that is hard, high in dissolved solids, and has high pH values. Although alkalinity is not a major problem in the Wise-Dickenson study area, some of the ground water in Powell Valley, especially among the carbonates, shows modest amounts of alkalinity. The State Water Control Board water quality criteria range from 30 to 500 milligrams per liter for the Valley and Ridge Physiographic Province, and from 30 to 200 milligrams per liter for the Cumberland Plateau.

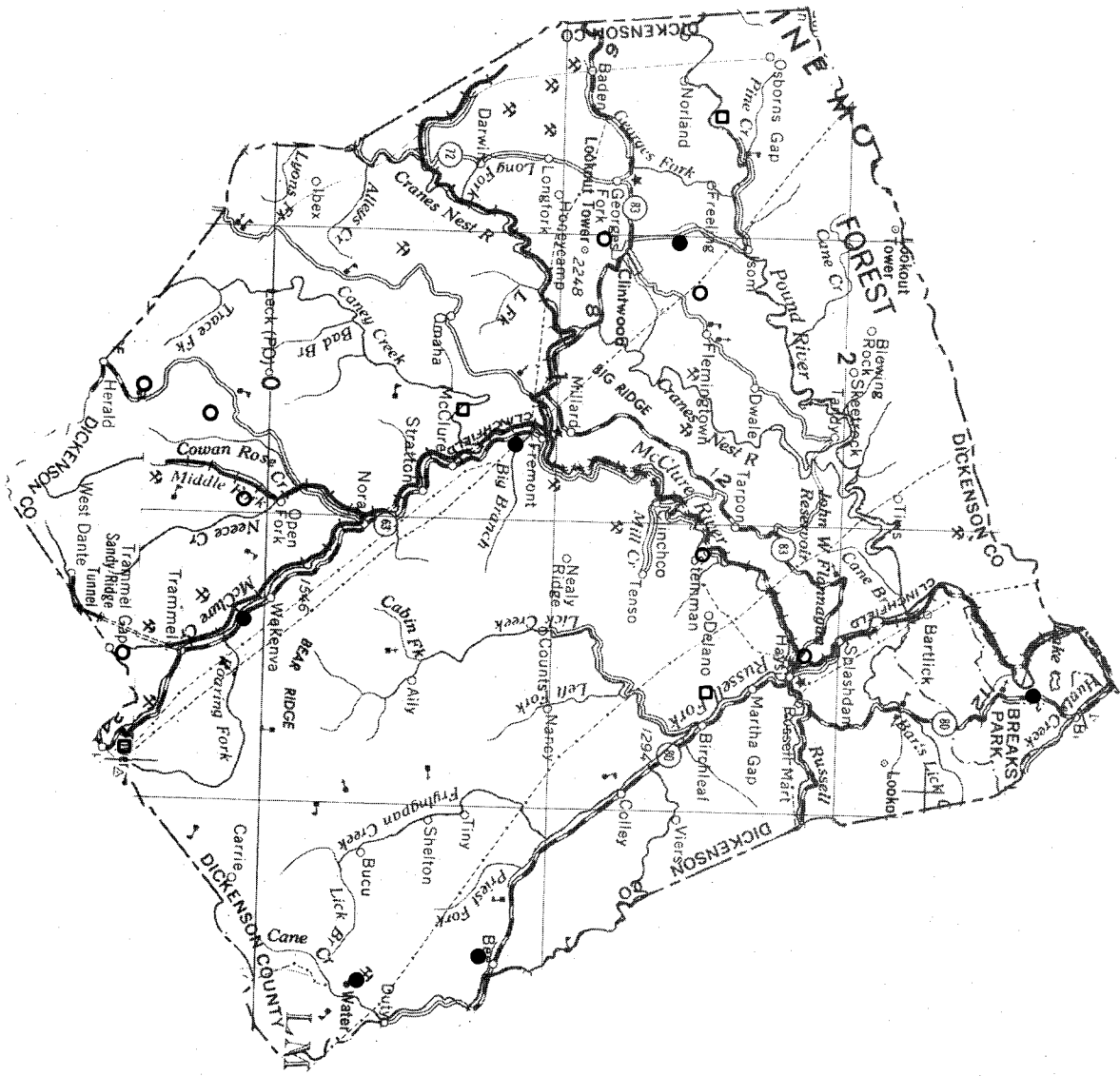
PH OF WELL WATER SAMPLES IN WISE COUNTY



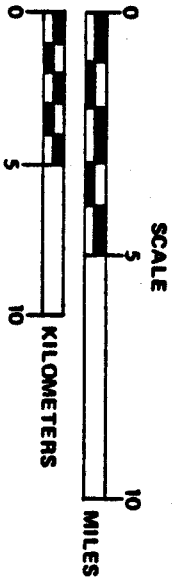
- LEGEND**
- LESS THAN 7.0
 - 7.0
 - MORE THAN 7.0



PH OF WELL WATER SAMPLES IN DICKENSON COUNTY



- LEGEND**
- LESS THAN 7.0
 - 7.0
 - MORE THAN 7.0



Corrosion problems seem to increase as pH values fall. In areas with a low pH, especially if salt and hydrogen sulfide are present, the effects of corrosion can be reduced by using plastic pipes, glass lined tanks and brass fittings. Although individual domestic water seldom is treated for low pH values, it is possible to raise the water's pH values by adding lime or soda ash. Low pH values for water used in the manufacture of carbonated beverages are beneficial, but the same water can cause corrosion of concrete. As noted above, water that is high in alkalinity also is associated with high pH values, high dissolved solids and hardness. Therefore, water that is high in alkalinity tends to form deposits known as "scale," in hot water heaters, pipes and boilers.

Chlorides

Most of the chlorides found in Wise and Dickenson Counties are chlorides of sodium that remained within the rocks when they were formed from seaborne sediments. The action of rainwater has removed most of the chlorides from the upper layers of rock, but ground water that is lower than 300 to 400 feet (91.4 to 121.9 m) below stream level becomes increasingly saline.

The Virginia Department of Health recommends that chlorides in drinking water not exceed 250 milligrams per liter due to taste considerations. Chlorides exhibit vigorous corrosive activity toward iron, steel and aluminum.

To reduce the amount of chlorides, it is recommended that water wells do not penetrate much beyond 300 to 400 feet (91.4 to 121.9 m) below the stream levels. Also, special care should be exercised in

locating water wells in areas where oil and gas exploration wells have been drilled, because they can act as conduits for the upward migration of salty ground waters from the depths. This also applies to coal mine test boring activity, in which the borings have been improperly plugged to prevent aquifer contamination.

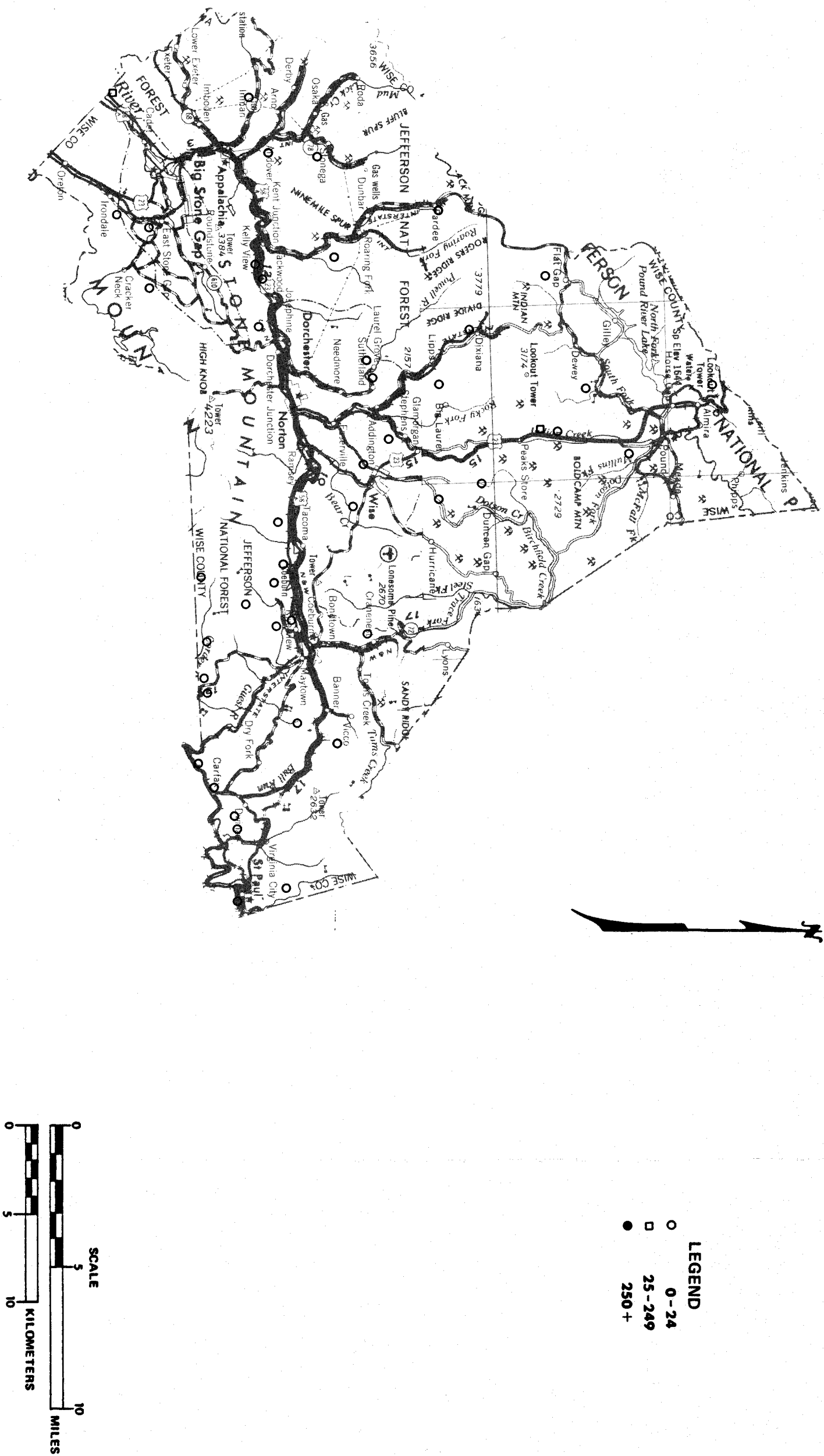
Hardness

Hardness refers to the soap-neutralizing power of a water. In most areas, calcium and magnesium ions are the principal causes of hardness, although any substance that forms an insoluble curd with soap causes hardness. The State Water Control Board water quality criteria recommend that hardness not exceed 300 milligrams per liter for the Valley and Ridge Physiographic Province, and 180 milligrams per liter for the Cumberland Plateau.

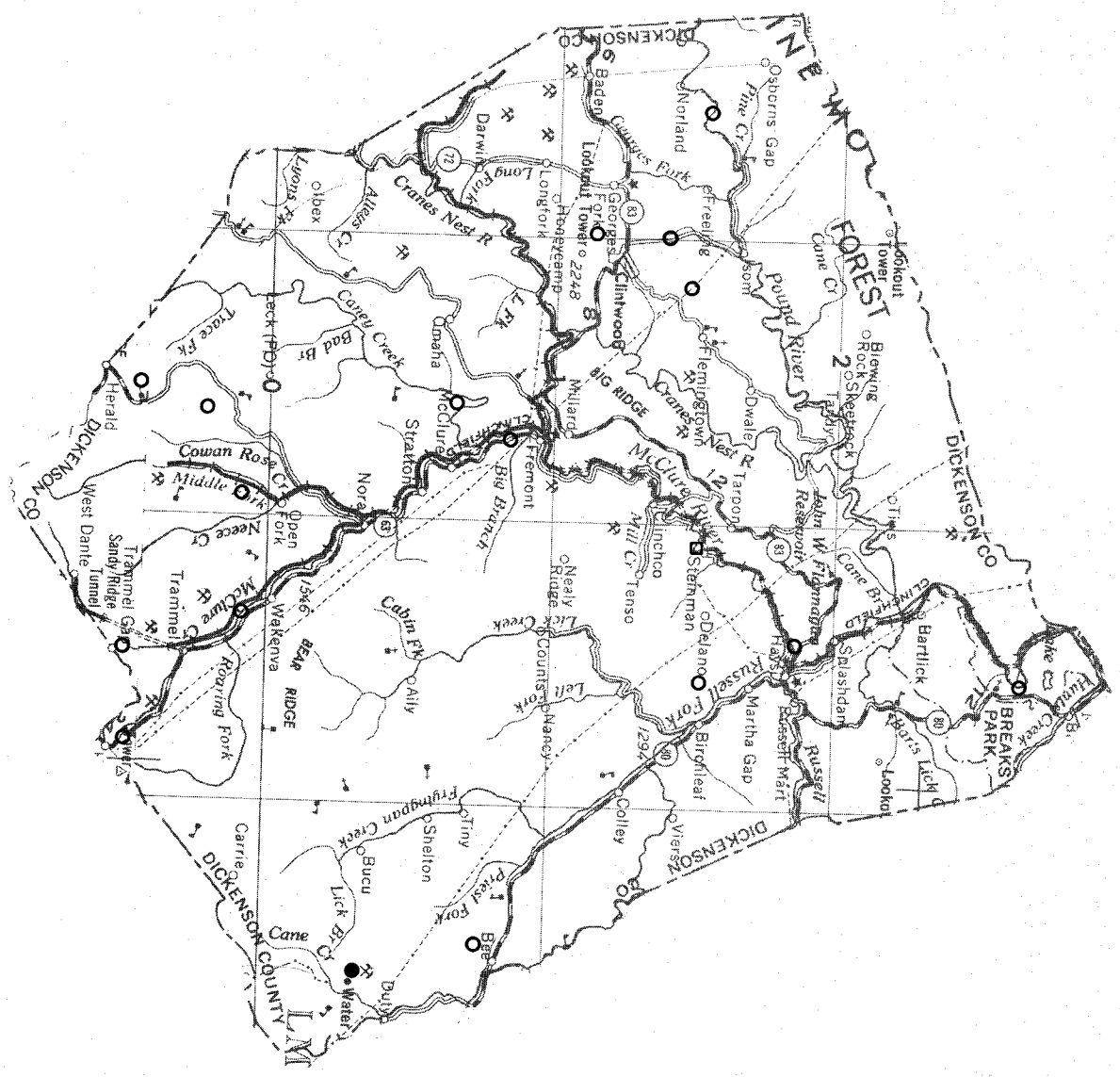
Since hardness is due mostly to calcium and magnesium ions within the water, the beds of limestone and dolomite within Powell Valley are the aquifers that exhibit the hardest waters in the study area. Some of the shales in the coal fields are moderately hard, while most sandstones have moderately soft water.

Hard water forms deposits on hot water heaters, boilers, water pipes and cooking utensils. Most water softeners will effectively soften waters that are hard due to calcium and magnesium ions, but have little effect upon acid, irony or sulfurous waters. In such cases, hardness can be best reduced by treating the water by the appropriate means only after chemical analysis has revealed the makeup of the water in question.

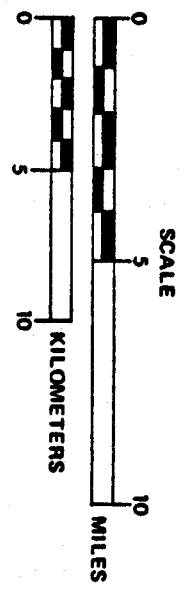
CHLORIDES IN MG/L FROM WELL SAMPLES IN WISE COUNTY



CHLORIDES IN MG/L FROM WELL SAMPLES IN DICKENSON COUNTY



- LEGEND**
- 0 - 24
 - 25 - 249
 - 250 +



Total Dissolved Solids

Total dissolved solids are comprised of all dissolved matters within a water. The Virginia Department of Health has a recommended secondary pollutant limit of 500 milligrams per liter for total dissolved solids in drinking water. It may be possible for water to contain compounds or combinations of compounds that make that water unsafe or unpleasant to drink and still meet the recommended level of total dissolved solids, so a thorough analysis is advisable.

Water that is high in dissolved solids can have an unpleasant taste, cloudiness and an undesirable color. It also can leave deposits on cooking utensils and hot water heaters, and it can cause foaming in boilers. Water that is high in dissolved solids can have a deleterious effect upon livestock and poultry, especially if they are exposed to it for a prolonged period of time.

Water from deeper aquifers tends to be higher in dissolved solids, usually due to salts within the lower aquifers.

Nitrates

Nitrates are almost never found naturally in rocks. They almost always occur as a byproduct of man-made activity, such as the application of chemical fertilizers or the discharge of certain effluents from sewage treatment plants or industrial processes.

Nitrates are quickly converted to organic nitrogen in the presence of sunlight, but in ground water this cannot occur. The Virginia Department of Health has a recommended limit of 10 milligrams per liter of nitrate as nitrogen. Because certain infants may be

subject to infant methemoglobinemia, or the so-called "blue baby disease," it is especially important that they not be exposed to nitrates above this amount.

Nitrates are not a problem in Wise and Dickenson Counties, but the potential for pollution due to the misapplication of chemical fertilizers in those areas of the counties subject to farming does exist.

Turbidity and Color

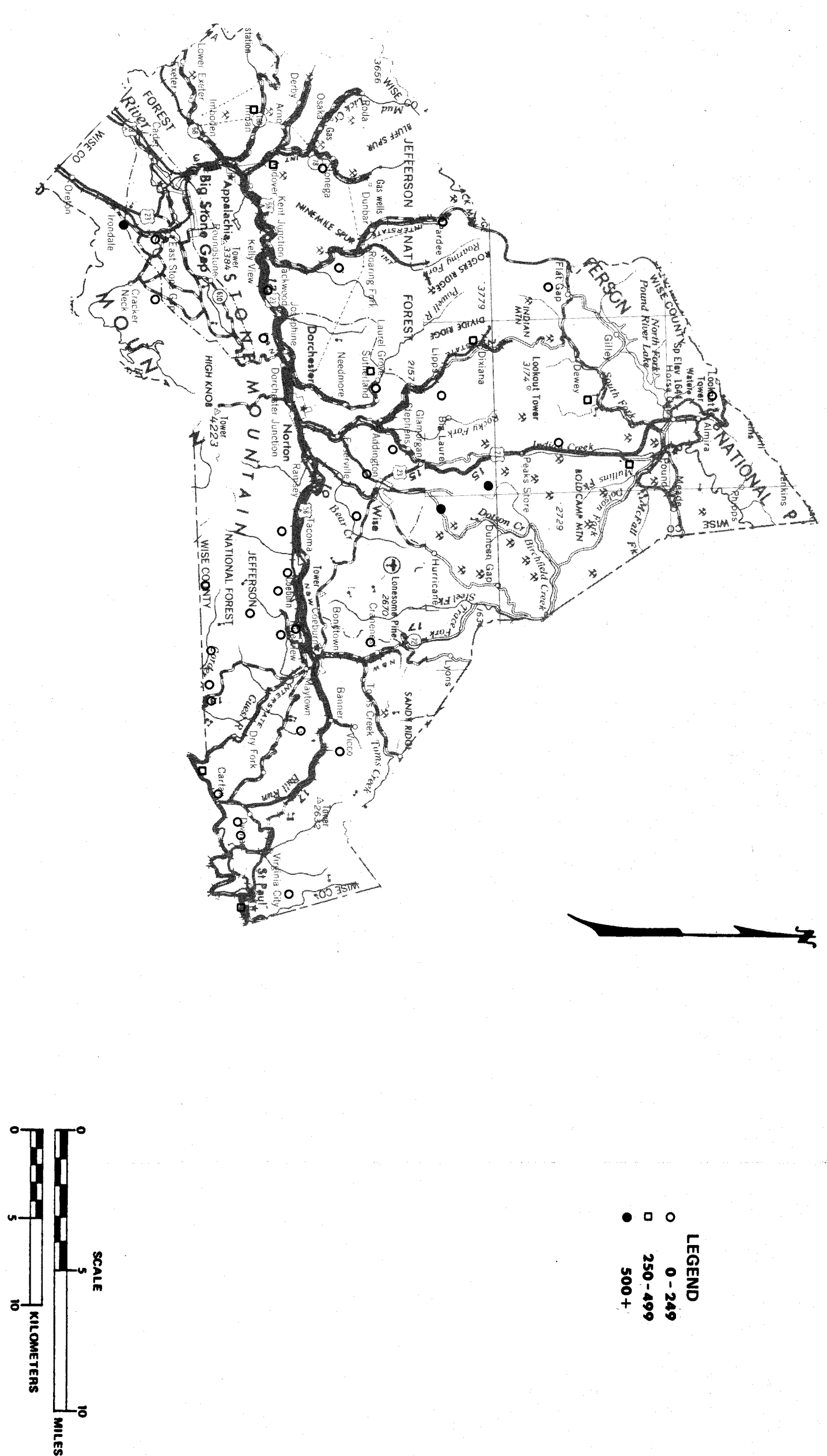
Turbidity is caused by small particles, such as soil, coal fines or rock powder, suspended in the water. It is often reflective of an improperly constructed well or a well that has been disturbed by mining, blasting or construction activity. Casing and grouting are designed to prevent such particles from reaching the ground water in wells, so turbidity may be a warning that the well may be subject to bacterial contamination. Such wells should be tested for bacteria by the respective County Health Departments. Well water that is consistently turbid can be treated by filtering.

Water color is caused by compounds dissolved within them. The two principal culprits are iron, which imparts a reddish color, and manganese, which causes a blackish color. Treatment for the offending compounds also clarifies the water.

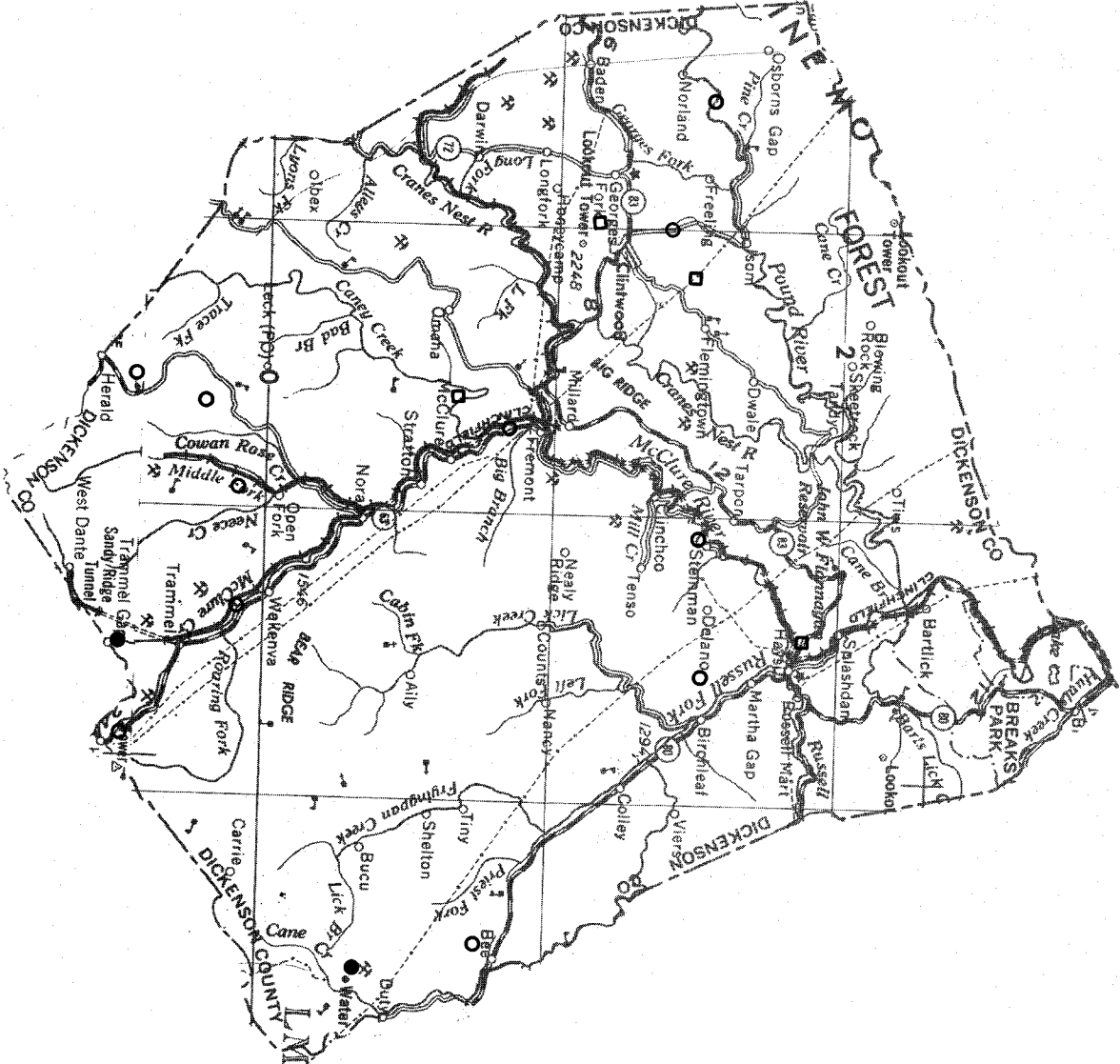
Bacteria

Bacterial contamination of ground water results from septic tank systems, privies, dumps, leaking sewers and surface waters that have not undergone natural filtration through the overlying soil or the aquifer.

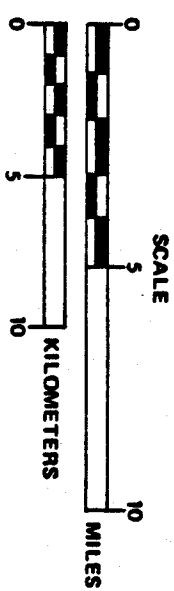
TOTAL DISSOLVED SOLIDS IN MG/L FROM WELL SAMPLES IN WISE COUNTY



TOTAL DISSOLVED SOLIDS IN MG/L FROM WELL SAMPLES IN DICKENSON COUNTY



- LEGEND**
- 0-249
 - 250-499
 - 500 +

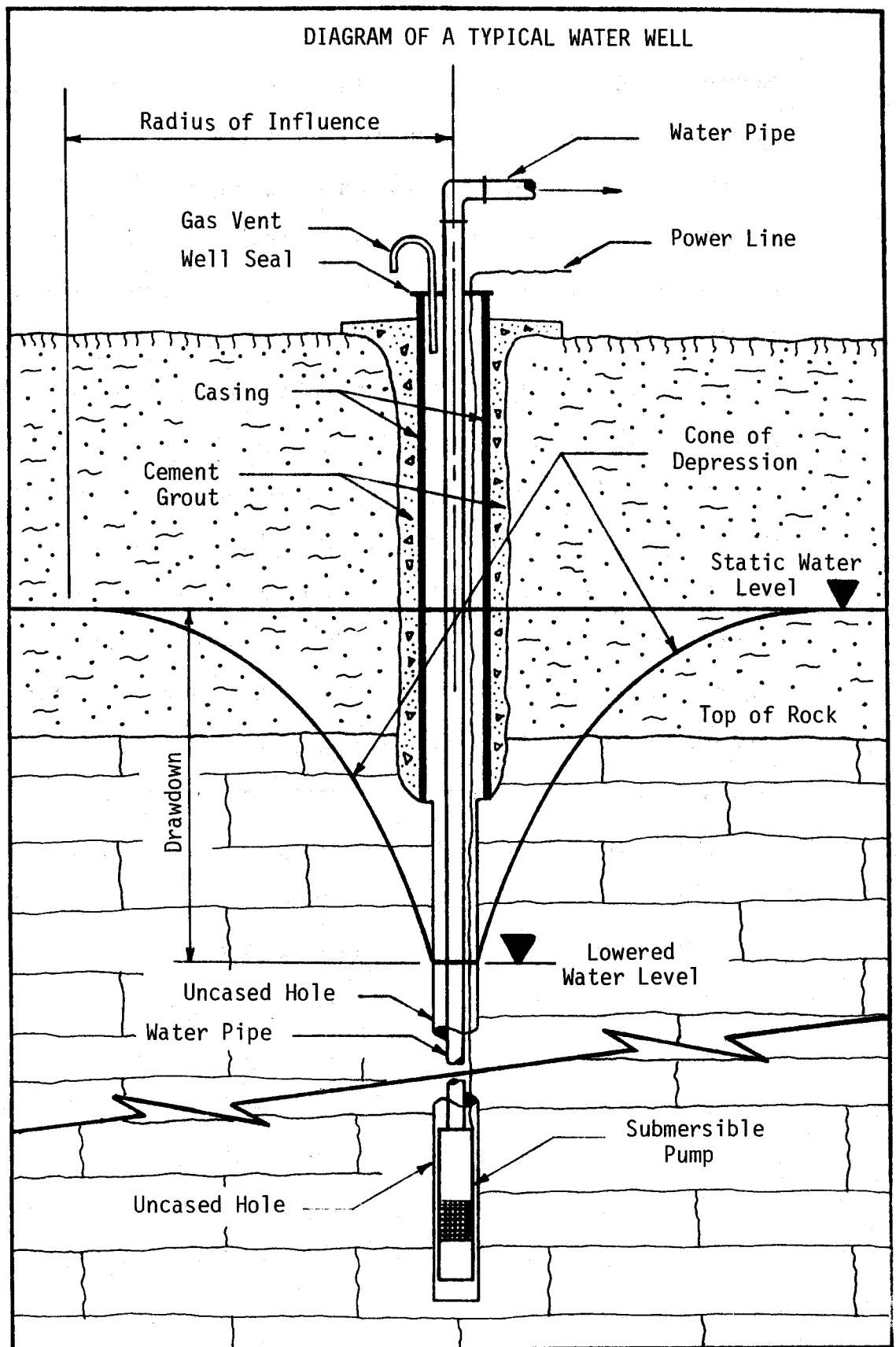


Carbonates (limestones and dolomites) have a great potential for bacterial contamination, because the caves, voids and solution cavities that form within them do not act as a natural filtering medium, and contaminated waters can travel large distances in a short period of time through them. Wells, especially shallow wells, located adjacent to major streams also may be highly vulnerable to bacterial contamination.

Dysentery and gastroenteritis, which can cause nausea, abdominal cramps and diarrhea, are the most common diseases transmitted by bacteria-polluted ground water. The new user is especially subject to the effects of polluted ground water, because continued use over an extended period of time enables many users to develop a tolerance to the bacteria's effects. Wells that may be suspected of harboring bacteria should be checked by the County Sanitarian from the County Health Department. The Sanitarian also can assist in locating new wells and in placing septic tank drainfields and privies.

Bacterial contamination of water wells can be avoided in most cases by proper placement uphill from septic systems and privies, casing and grouting to bedrock, and installing a sanitary well seal. In those cases where the aquifer itself is contaminated, the installation of a chlorine contact tank may be necessary.

Plate 22 is a diagram of a typical water well with casing and grouting to bedrock and a sanitary well seal. The chances of pollution are greatly reduced if casing is set in bedrock and grout is installed to a depth of at least 50 feet (15.3 m).



Source: Virginia State Water Control Board

PLATE NO. 22

CHAPTER V

GROUND WATER DEVELOPMENT

Present Use

Nearly all small developments, businesses, schools and domestic dwellings that lie outside the major towns in Wise and Dickenson Counties depend upon wells for their supply of water. Few problems in obtaining adequate supplies are encountered in Powell Valley, because the slopes of Powell Mountain, Stone Mountain and Little Stone Mountain direct runoff toward the thick soil cover and alluvial deposits that cover the valley floor, enhancing recharge. Most wells in this area that fail to provide adequate yields are quite shallow, and the water table will occasionally fall below them during times of extended drought.

In the coal fields of Wise and Dickenson Counties, the largest-yielding wells are usually associated with coal mining operations. These wells tend to skew the data toward higher than normal yields, because inadequate yields are usually not reported.

Appendices A and D show the location of key water wells in Wise and Dickenson Counties, respectively, that are on record with the State Water control Board, and Plate Nos. 23 and 24 show recorded yields in those counties. Many of these yields are industrial or commercial wells, because pump tests are seldom performed or needed for domestic supplies. As is to be expected, the higher yields are in the broader valleys that are stream-fed.

Domestic Wells

Most domestic wells in Wise and Dickenson Counties range in depth from 150 to 250 feet (45.7 to 76.2 m) deep, although a few are less than 50 feet (15.2 m) or more than 500 feet (152.4 m) deep.

During times of drought or seasonal lowering of the water table, usually in late summer, some of the shallower wells experience lower yields and a deterioration in quality. The latter usually is caused by increased pumping required to meet the needs of the user, which in turn may increase the radius of influence of the well (see Plate 22) and bring in water from less potable zones.

Plate 22 shows a diagram of a typical water well, cased and grouted to bedrock, and with a gas vent to the outside of the well house. This latter feature is important to the wells located within the coal fields of both Wise and Dickenson Counties, where methane may accumulate, especially in those wells that have penetrated coal seams that have not been cased off.

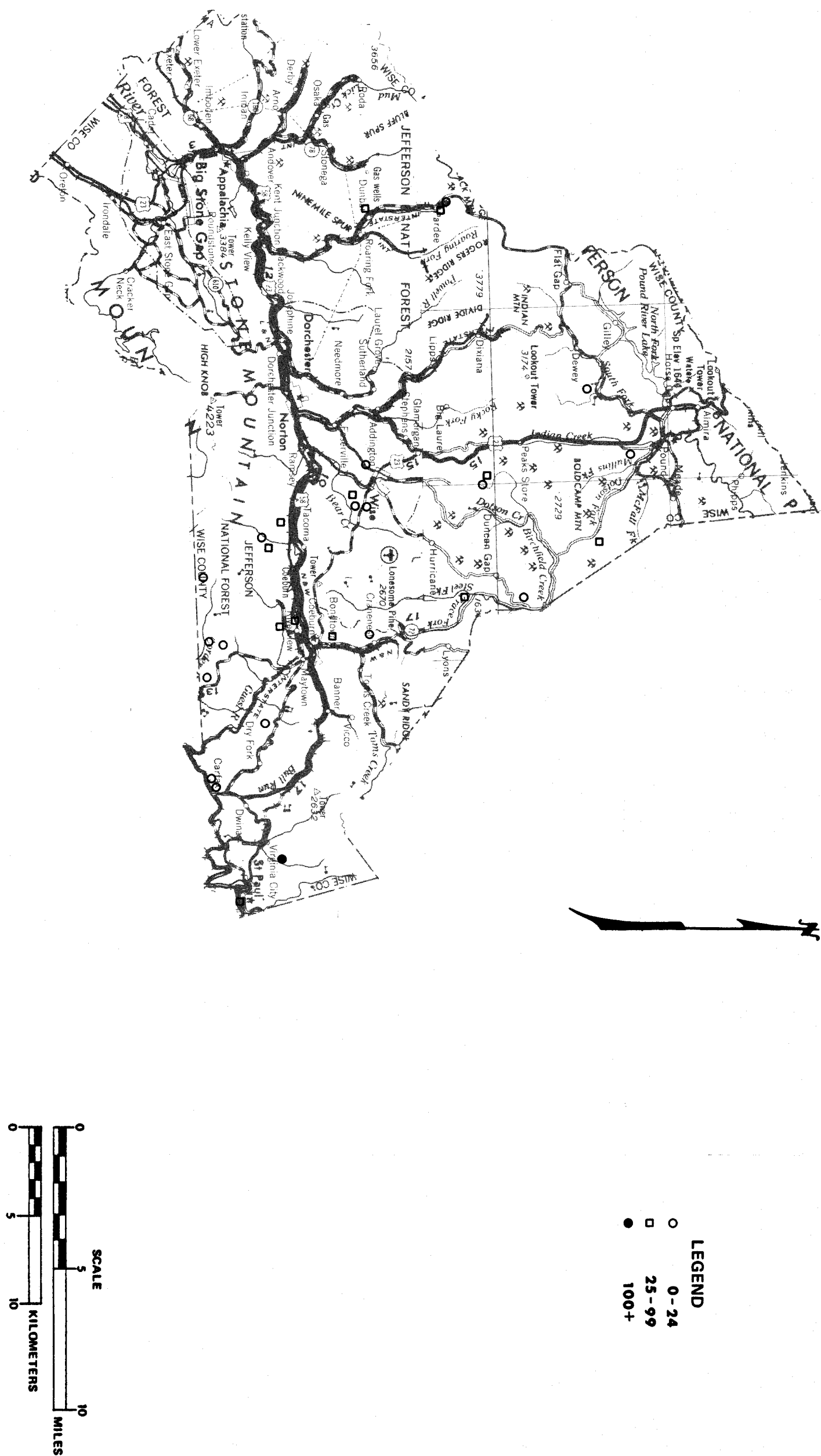
Domestic wells have a greater likelihood of adequate yields if they are located in topographically low areas, but such locations are prone to contamination from privies and septic tank drainfields which may be above them. The local County Sanitarian from the County Health Department will assist in the location of new domestic wells, as well as the siting of septic tank drainfields.

Water wells in Wise and Dickenson Counties seldom should extend 300 to 400 feet (91.4 to 121.9 m) below the valley floors, because the weight of the overburden tends to close down the openings necessary for ground water storage and transportation, and the quality of the water deteriorates beyond this depth, with the water becoming increasingly saline.

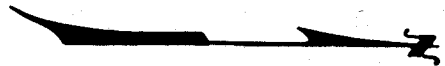
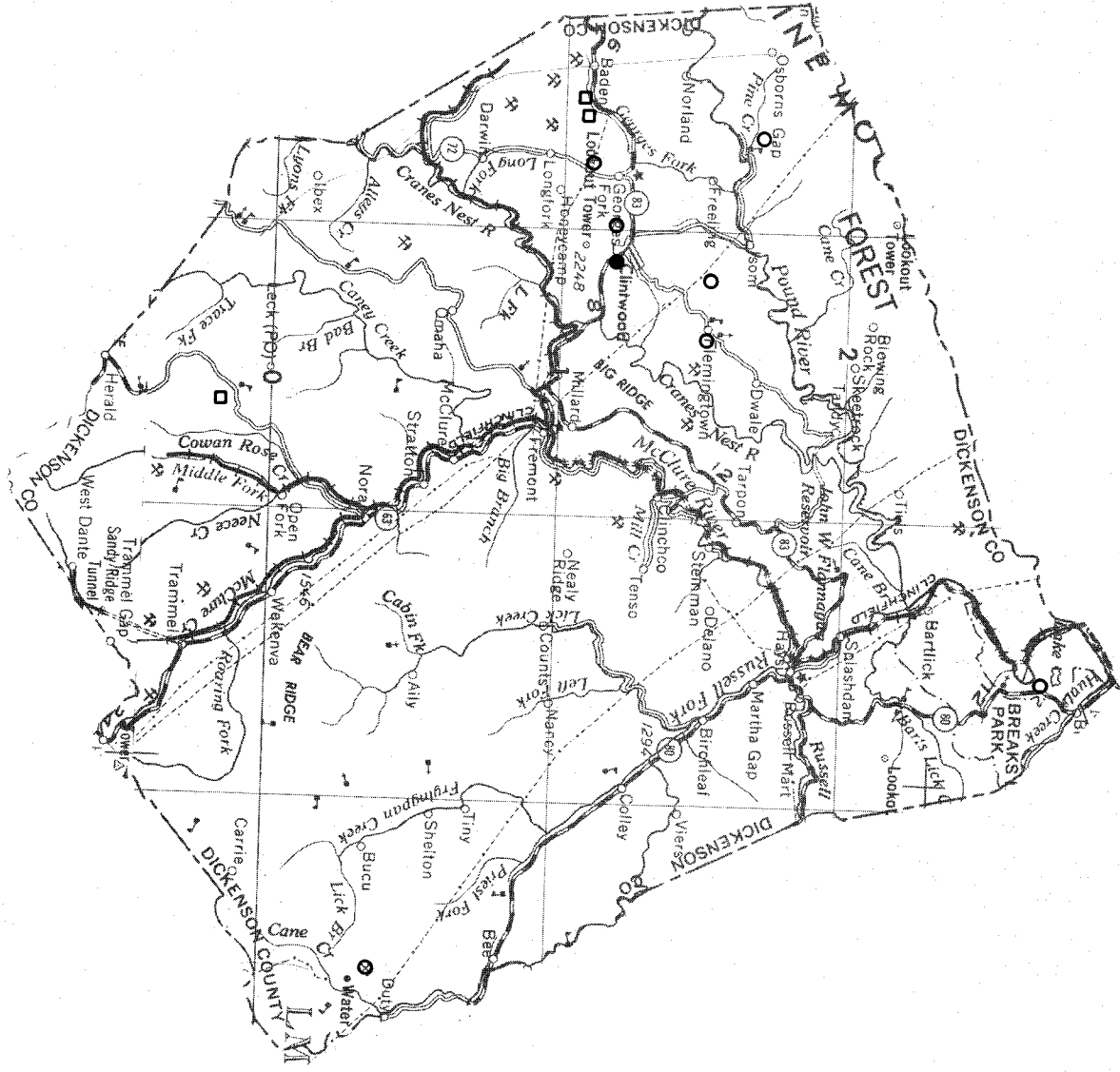
Larger Industrial and Public Supply Wells

No well can extract from the ground more ground water than the underlying aquifers are physically capable of yielding, but careful

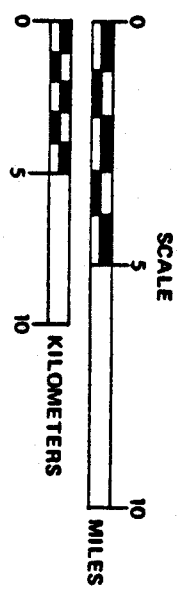
WELL YIELDS IN GALLONS PER MINUTE IN WISE COUNTY



WELL YIELDS IN GALLONS PER MINUTE IN DICKENSON COUNTY



- LEGEND**
- 0 - 24
 - 25 - 99
 - 100 +



site selection and a variety of techniques can be employed to obtain the maximum yield without harming the aquifer.

The larger stream-fed valleys provide the best areas for the development of higher yielding wells required by public supplies and industries. Often a single well is inadequate, but a series of widely spaced wells pumping alternately may supply the requirements of the larger users. Alternate pumping prevents the excessive lowering of the water table in a small area and provides the economic advantage of extended pump life. Such a system also ensures a continuous flow, allowing pump replacement or other well work to take place without complete disruption to the system.

Larger yields often can be obtained by using larger than normal well diameters. The 8-inch (20.3 cm) or 10-inch (25.4 cm) diameter opening may provide the difference between an adequate or inadequate yield when compared to the standard 6-inch (15.2 cm) well diameter. Increasing the diameter of a well seldom provides a dramatic increase in yield, but it may be beneficial to use them when supplies are marginal to slightly inadequate.

Another method to increase yield involves the use of blasting to fracture the aquifer at depth, thereby increasing the permeability and porosity of the rock. Such attempts are usually expensive, localized and provide mixed results at best.

CHAPTER VI

GROUND WATER PROBLEMS

General

Both the domestic and industrial extraction of ground water from beneath the Wise-Dickenson County area can create problems with the quality and quantity of those waters. Surface activities can also have a profound effect upon the water that lies beneath them. It is the purpose of this chapter to point out those actions that may be harmful to the ground water, some methods to prevent such abuses, and to try to create an awareness as to the value of ground water and its delicate nature.

Overpumping

An aquifer is overpumped when the amount of ground water taken from it exceeds the amount of recharge to it. It may be either localized or regional, and its duration may be short-term or long-term.

Short-term overpumping, especially if confined to a local area, may not be particularly harmful to an aquifer, and the benefits may outweigh the harm if, for example, the overpumping is necessary to meet the water requirements during the time of a drought.

Long-term overpumping lowers the water table and can affect both ground water users and the aquifers. The lowering of the water table initially can cause the shallower wells to go dry, and bring about a deterioration in ground water quality by bringing up saline waters from deeper formations.

Long-term overpumping is not necessarily confined to intense, large-volume users; it can be caused by numerous, small-volume consumers confined to a small area. The steep ridges that form between the valleys in the coal fields often act as barriers to the aquifers below them, permitting little lateral flow of ground water. Therefore, development in one valley can seriously reduce the ground water availability in that particular area while the adjacent valley is largely unaffected.

Most water wells will provide clues that they are becoming dry by showing increased turbidity, discoloration or altered taste, although the user may not know the cause of the water's deterioration.

Occasionally, the lowering of the pump may be all that is required, but a chronic or seasonal lowering of the water table resulting in the loss of water or a decrease in quality may be rectified by either drilling the existing well deeper or drilling a new, deeper well.

Industrial Activity

Industrial activity, both at the surface and at depth, can have a profound effect upon surface and ground water. Mining operations and their ancillary activities pose the greatest threat to the ground water in Wise and Dickenson Counties.

Dewatering

One of the more serious hazards is that of dewatering, in which mining activities beneath an aquifer will drain it, causing any wells within it to go dry. This is an event that neither party wants.

Mine water imposes an economic burden as well as a safety hazard.

Most mine water is removed from the mine by pumping, which is the

most economical and efficient method of dealing with it. However, such a procedure does nothing to restore the aquifer and probably speeds its dewatering. Attempts to grout or seal all but the smallest inflows are expensive, dangerous and may prove ineffective.

Most drift mines in the valley walls are above the water table, and few wells find productive zones above them. Mines that are deeper than 400 feet (121.9 m) below the valley floors usually have few problems with significant water inflows, because the weight of the rocks above them closes down the openings that can transmit ground water.

Dewatering of water wells in the coal fields that occurs suddenly, particularly in wells that are deep or have no history of trouble, is often thought to be related to mining activity. Although the likely cause is suspected in such cases, the ability to prove the cause, and particularly the source, is extremely difficult.

Protection of Aquifers

Mine shafts, exploratory drill holes and abandoned water wells can be sources of aquifer contamination, permitting the upward and downward migration of ground water.

The proper abandonment procedure for a water well is as follows:

- (1) Casing and screen materials may be salvaged.
- (2) The well should be checked for obstructions that may interfere with sealing operations.
- (3) The well should be thoroughly chlorinated prior to sealing.
- (4) The well should be completely filled with cement grout or dry clay compacted in place. The grout should be composed of no more than

5-1/2 gallons (20.8 l) of water per bag of Portland Cement, and should contain no sand since this increases the porosity of the grout.

Deterioration of Ground Water Quality

Water quality can be lowered by a variety of factors. It has been explained above how overpumping and subsurface mining activities can bring about a lowering of the water table and subsequent deterioration in the ground water.

Surface activities can also cause ground water contamination. They can be either industrial or private. The denuding of vegetation for surface mining activities and construction activities can cause siltation of streams and increases runoff, reducing ground water recharge. Mining operations can increase iron and acidity by exposing coal in underground workings and refuse piles on the surface to oxidation, releasing them into the ground water.

Blasting and construction activities can cause turbidity in adjacent wells, although often the wells will regain much of their clarity after such operations are terminated.

The limestone beds of Powell Valley and the St. Paul area are vulnerable to bacterial contamination, because the chemically-active nature of the rocks often will cause them to be filled with inter-connecting voids, solution cavities and caves that can transmit contaminated water over long distances in a short period of time without undergoing the natural filtration inherent in many other types of aquifers.

In the coal fields this is less of a problem, although improperly constructed wells may pick up surface bacteria, and wells that are

improperly located near privies and septic tank drainfields are vulnerable to bacterial contamination.

Landfills and Dump Sites

The threat to ground water from leaking landfills and dump sites is just now becoming widely recognized. A growing number of materials that are toxic to humans and the environment, the refuse of a growing population, and the diminishing availability of suitable land for proper disposal for them, all conspire to endanger ground water supplies.

The selection, design and operation of such sites must be done with sufficient preparation, review and monitoring to ensure that ground water is protected.

Once ground water is contaminated, it may remain so permanently, since it lacks the self-cleaning mechanisms of surface water.

The cost will not be cheap, but it is far less expensive than the price of reclamation, or having an aquifer permanently destroyed.

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CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

With the anticipated demand for increased coal production to help meet the nation's independent energy needs, the Wise-Dickenson County area will experience an ever-increasing demand upon its water supplies. The need for ground water also will increase to supply the industrial, particularly mining, and the domestic needs. However, unless sufficient steps are taken now to try to determine the overall quality and quantity of ground water in the area, future development may be restricted.

It will become necessary to understand the ground water conditions in the Wise-Dickenson County area in great detail so careful planning and management can be made in an intelligent manner. The basis for this understanding will be detailed, accurate information that must go beyond the small samples of water wells that are currently available. Only by broadening the data base can areas of potential ground water harm be spotted early, and corrective measures undertaken.

There appears to be sufficient ground water availability to fulfill the needs of the present population with moderately deep wells, but an increasing population and mining activity may lower the overall water table and place distress upon the owners of the shallower wells.

Increased deep mining activity also poses the threat of subsidence, causing the overlying water-bearing strata to settle and crack, draining the aquifers through these fissures.

An increased population also increases the threats to ground water contamination due to septic tank drainfield usage, broken sewer lines and increased demands for sanitary landfills.

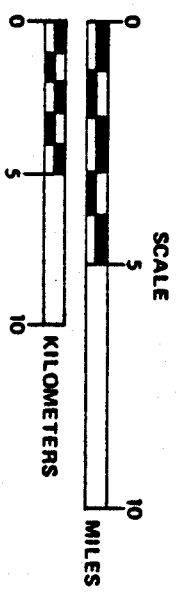
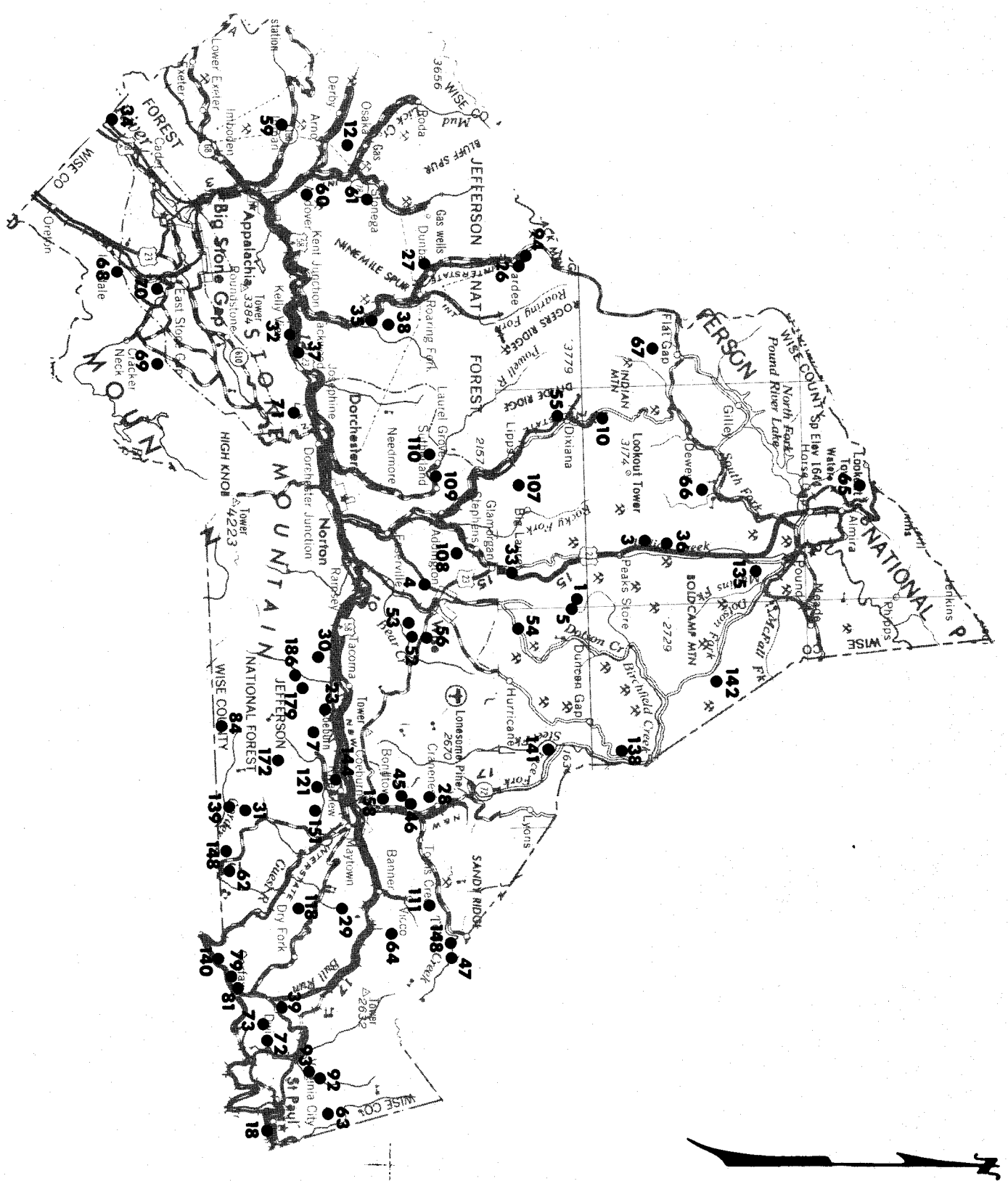
Only by recognizing these threats and planning to deal with them in their early stages can irreparable harm be prevented from being imposed on the delicate, valuable ground resources in the area.

APPENDIX A

KEY WATER WELLS IN WISE COUNTY

The following Wise County map shows approximately 70 wells which are included in Appendix B. The numbers appearing next to each well may be cross-referenced with the information contained in Appendices B and C.

KEY WATER WELLS IN WISE COUNTY



APPENDIX B

SUMMARY OF WATER WELL DATA FOR WISE COUNTY

The following pages have been compiled from computer print-out sheets for the Wise County area. The printout is updated to include information from new Water Well Completion Reports submitted by water well drilling contractors. The locations of many of the wells may be found in Appendix A.

VIRGINIA STATE WATER CONTROL BOARD

***** EXPLANATION OF TABLE *****

THE VIRGINIA STATE WATER CONTROL BOARD MAINTAINS A FILE OF WATER-QUALITY ANALYSES OF GROUND WATER FROM SELECTED WELLS AND SPRINGS. THE FOLLOWING TABLE IS A SUMMARY OF THESE ANALYSES. ADDITIONAL INFORMATION IS AVAILABLE FOR MANY OF THESE WELLS AND SPRINGS AND CAN BE OBTAINED BY CONTACTING THE BUREAU OF SURVEILLANCE AND FIELD STUDIES.

SWCB NO (STATE WATER CONTROL BOARD NUMBER): SEQUENTIAL NUMBER APPLIED TO WELLS WITH INFORMATION ON FILE. WHEN REQUESTING ADDITIONAL INFORMATION, PLEASE REFER TO THIS NUMBER.

OWNER AND/OR PLACE: ORIGINAL OR CURRENT OWNER OF THE WELL AND/OR ITS GEOGRAPHIC LOCATION.

DATE SAMP (DATE SAMPLED): MONTH AND YEAR IN WHICH THE WATER SAMPLE WAS COLLECTED.

PH: A PARAMETER WHICH INDICATES WHETHER WATER IS ACIDIC OR BASIC. A PH VALUE OF 7.0 INDICATES WATER WHICH IS NEUTRAL. A PH VALUE OF LESS THAN 7.0 INDICATES THAT WATER IS ACIDIC AND A PH VALUE OF GREATER THAN 7.0 INDICATES THAT WATER IS BASIC. A PH VALUE OF LESS THAN 6.5 OR GREATER THAN 8.5 IS CONSIDERED BY THE HEALTH DEPARTMENT TO BE A SECONDARY CONTAMINANT.

SPEC COND (SPECIFIC CONDUCTANCE): THE ABILITY OF WATER TO CONDUCT AN ELECTRIC CURRENT AS A RESULT OF DISSOLVED MINERAL MATTER, USED AS AN APPROXIMATE INDICATOR OF THE AMOUNT OF DISSOLVED MINERALS IN WATER. UNIT OF MEASURE IS MICROMHOS PER CENTIMETER.

T-DIS SOLID (TOTAL DISSOLVED SOLIDS): A MEASURE OF THE TOTAL AMOUNT OF DISSOLVED MINERAL MATTER IN WATER. UNIT OF MEASURE IS MILLIGRAMS PER LITER.

HARDNESS-TOTAL: A PARAMETER WHICH INDICATES THE EFFECTS OF CALCIUM, MAGNESIUM, AND OTHER METALS ON THE ABILITY OF WATER TO MAKE SOAP LATHER. UNIT OF MEASURE IS MILLIGRAMS PER LITER EXPRESSED AS CALCIUM CARBONATE.

HARDNESS-CALCIUM, MAGNESIUM: HARDNESS CONTRIBUTED BY CALCIUM AND MAGNESIUM. THE PRINCIPAL METALS WHICH CAUSE HARDNESS IN WATER. NOTE-BECAUSE TOTAL HARDNESS IS DETERMINED BY CHEMICAL TITRATION, WHEREAS CALCIUM-MAGNESIUM HARDNESS IS A MATHEMATICAL CALCULATION, CALCIUM-MAGNESIUM HARDNESS VALUES MAY BE HIGHER THAN TOTAL HARDNESS VALUES.

FE (IRON): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 0.3 MG/L, IRON IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

MN (MANGANESE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 0.05 MG/L, MANGANESE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

CA (CALCIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

MG (MAGNESIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

NA (SODIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

K (POTASSIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

ALK (ALKALINITY): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

SO₄ (SULFATE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 250 MG/L, SULFATE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

CL (CHLORIDE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 250 MG/L, CHLORIDE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

N₃/N (NITRATE AS NITROGEN): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 10 MG/L NITRATE NITROGEN IS CONSIDERED TO BE A PRIMARY CONTAMINANT BY THE HEALTH DEPARTMENT.

NOTE: ALL ZEROS INDICATE PARAMETER ANALYZED BUT NOT DETECTED

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SUMMARY OF WATER WELL DATA FOR WISE COUNTY

SWR NO.	OWNER	VA. PLANE NORTH	COORD EAST	DRILLER	YR COMP	ELEV	TOTAL DEPTH	PUMP LEVEL	ZONES OR SCREENS	YIELD	RED-ROCK	FORMATION	LITH-OLGY	LOGS TYPE
1	CLINCHFIELD COAL CO	282100	0810000	PAYNE	70	1860	300	40	42	25	50	PENN	SS	IND
2	TELEVISION STATION			FUNK	70		505	200		1		PENN	SS	COM
3	BUDDY'S DINE & DANCE	292600	0803750	FUNK	71	1620	245					PENN	SS	COM
4	WISE COUNTY JAIL	260000	0808700	FUNK	73	2455	275	25	40	70	10	PENN	SL	IND
5	CLINCHFIELD COAL CO	281900	0810200	FUNK	71	1860	220			20	10	PENN	SS	IND
6	CLINCHFIELD COAL CO			KFEN	71		305	180		1		PENN	SH	IND
7	MARTY CORP	243200	0828500	FUNK	72	2020	110	6		40		PNG	SS	COM
8	OBSERVATION WELL #52			MARTIN	69		500					PNG	SS	PUR
9	U S FOREST SERVICE				16	2260	118			200		PENN	SS	IND
10	COAL PROCESSING CORP	284600	0782200			1760	600			150		PENN	SS	ARD
11	STUART A STIDMAN #1	250050	0744500			1760	600			20				COM
12	STUART A STIDMAN #2	250250	0743750							20				COM
13	CLINCH HAVEN FARMS									20				COM
14	CLINCH HAVEN FARMS									20				COM
15	LICK CREEK WATER SYS			YEARY	67		198	20	44	20	9			PWS
16	LICK CREEK WATER SYS			YEARY	67		175	23	62	20	9			IND
17	LICK CREEK WATER SYS			YEARY	67		295	29	50	21	20			PWS
18	ST PAUL COLA-COLA	230050	0806700		36	1475	84	12		52		LAMR PNG	LS	IND
19	TOWN OF COEBURN				48		301							ARD
20	CLINCH R IND DEV CORP													IND
21	TOWN OF WISE													ARD
22	TOMS CREEK													ARD
23	ODLE'S CHRYSLER-PLY.	244700	0825250	FUNK	73	2130	500	125		1			SS	COM
24	CLAYBURN FLOOMER									20				PWS
25	WISE COUNTY									22				PWS
26	SUNRISF COAL CORP.									27				PWS
27	WESTMORELAND COAL CO.									60				PWS
28	JOHN KILGORE									5				PWS
29	JOHN MARKHAM													PWS
30	WILLIAM SLUGS													PWS
31	FLATWOODS JOB CORPS	257850	0839750	YEARY	74	2130	60					OENN	SS	DOM
32	HUBERT GIBSON	246250	0854100	YEARY	65	2030	116	23	51	30		OENN	SS	DOM
33	WARD MOBILE HOME SALE	244200	0817400				700	575	505	15				DOM
34	GILMER LITTON													PWS
35	W M DAY													PWS
36	RAY BUCHANAN	240800	0770950											PWS
37	CENTRAL DRIVE-IN THEA	271450	0805400											PWS
38	WESTMORELAND COAL CO	215750	0738200											PWS
39	WISE CO. SCHOOLS	250700	0767200											PWS
40	VA DEPT OF WELFARE &	294600	0803750											PWS
41	VA DEPT OF WELFARE &	241100	0771100											PWS
42	VA DEPT OF WELFARE &	250900	0767000											PWS
43	STONEGA COKE & COAL	232222	0869025											PWS
44	STONEGA COKE & COAL													PWS
45	VA IRON COAL & COKE	254150	0837350											PWS

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SUMMARY OF WATER WELL DATA FOR WISE COUNTY

SWCH NO.	OWNER	VA. PLANE COORD NORTH EAST	DRILLER	YR COMP	ELEV	TOTAL DEPTH	SWL PUMP LEVEL	ZONES OR SCREENS	YIELD	RED- ROCK	FORM- ATION	LITH- OLOGY	LOGS TYPE
46	VA IRON COAL & COKE	254300 0838000				107							IND
47	VA IRON COAL & COKE	262400 0868200				500							IND
48	VA IRON COAL & COKE	262400 0867800											IND
49	VA IRON COAL & COKE					246							PWS
50	TOWN OF APPALACHIA												IND
51	CLINCH RIVER IND DEV												PWS
52	CLINCH VALLEY COLLEGE	257150 0815250				300			15				PWS
53	JIMS MINUTE MART	257479 0812395		74	2500	102			30				COM
54	SHOP SANITARY LANDFIL	271754 0814715		73	2330	155	90						PUR
55	OLD BEN COAL CO	279916 0783088	BLANKENSH	64	2240								IND
56	SUNOSTRAND CORP		FUNK	75		420	65		15				IND
57	APPALACHIA ELEM SCH #1		FUNK	75		400	100		2				PWS
58	APPALACHIA ELEM SCH#2		FUNK	75		275	74		51				PWS
59	WESTMORELAND COAL CO	240463 0737447			1840	130							IND
60	WESTMORELAND COAL CO	247278 0752307			1960								IND
61	WESTMORELAND COAL CO	257866 0750999		69	1960	100							IND
62	WAYNE STEELE	225136 0847024	YEARY		2440	130							DOM
63	F J SULLIVAN JR	241593 0879973			1740	130							DOM
64	W L NICHTIE	251639 0857149			2765	85							DOM
65	FRANKLIN TACKITT	325204 0796029			2380	280							DOM
66	ALBERT J KINZER	302214 0793967		75	1640	190			10				DOM
67	WILLIAM CANTRELL	295989 0769926			1980	111							DOM
68	JOE BLEDSOE	215357 0755256			1670	206							DOM
69	PAUL RYINGTON	222881 0772596			1740	105							DOM
70	CARL R STURGILL	217216 0754445			1640	215							DOM
71	BEN SPRADLIN	239951 0784898			2360	150							DOM
72	HARRY WRIGHT	231771 0875103			1600	120							DOM
73	JAMES T EVANS	235321 0869965			1660	30	20						DOM
74	HARBERT HUGHES		FUNK	75		250	220		40				DOM
75	ROBERT BATHIS		FUNK	75		500	150	777	1				DOM
76	DICKENSON ENTERPRISE		FUNK	75		275			9				DOM
77	EMORY ROBERTS		FUNK	75		175							DOM
78	DENVER ROGGS		FUNK	75		275	38		1				DOM
79	DAVID REAM	225200 0862400		75	200	60			5				DOM
80	HERALD ASSEMBLY OF GOD		FUNK	75		275	100		3				DOM
81	ROB MOORE	225900 0843300					1						DOM
82	RO EDWARDS		FUNK	75	275	100							DOM
83	ARLAN COLLINS		FUNK	75	400	200			10				DOM
84	JUNIOR & GLENN HAMILTON		FUNK	75	150	50			3				DOM
85	AVERY ROSE	232100 0826500		75	600	100			50				DOM
86	JAMES LOUDEN		FUNK	75	500	100			1				DOM
87	FLDER STANLY		FUNK	75	150	40			1				DOM
88	GARY SIRRATT		FUNK	75	500	160			2				DOM
89	JERRY TIGNOH		FUNK	75	275	100							DOM
90	EASTOVER MINING		FUNK	75	315								IND

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SUMMARY OF WATER WFL DATA FOR WISE COUNTY

SWCR NO.	OWNER	VA. PLANE COORD NORTH EAST	DRILLER	YR COMP	ELEV	TOTAL DEPTH	SML PUMP LEVEL	ZONES OR SCREENS	YIELD	RED- ROCK	FORM- ATION	LITH- OLOGY	LOGS TYPE
91	PAUL F MULLINS		FUNK	75	1610	500			143				D
92	EASTOVER MINING CO	237059 0879463	FUNK	74	1590	275	50						D
93	EASTOVER MINING CO	234902 0877750	FUNK	75		500			3				D
94	BLACKWOOD FUEL CO		FUNK	75		125	30		10				D
95	JIMMY FLEMING		FUNK	75		325			1				D
96	JOE GILLIAN		FUNK	75		275	145		1				D
97	ROBERT GARDNER		FUNK	75		350			2				D
98	ARTHUR AGNEW		FUNK	75		275	100		1				D
99	WILLIAM FRANK PERRY		FUNK	75		450	90		10				D
100	LESTER SANDERS		FUNK	75		325			1				D
101	THOMAS PAYNE		FUNK	75		175	50		1				D
102	ARON BRANHAM		FUNK	75		400	175		1				D
103	LEOLA RINER		FUNK	75		325			50				D
104	IVAN ROSE		FUNK	75		325	55						D
105	TIM PENNINGTON		FUNK	75		2360							D
106	CITY OF NORTON		FUNK	75		2200	37						D
107	JOE SLOCE	275976 0792087	FUNK	76		2120							D
108	JIM STURGILL	263636 080112P	FUNK	76		2320							D
109	PHYLLIS DEAN	257400 0795577	FUNK	76									D
110	WILLY CLISSO	261661 079072P	FUNK	76		375			1	125			D
111	DAYL COOMER	260800 0854950	FUNK	76		175	30		12	27			D
112	VERNON SCRUGGS		FUNK	76		50			30				D
113	CECIL BORINETTE		FUNK	76		275	180		100				D
114	LAMBERT COAL		FUNK	76									D
115	MUNCY		FUNK	76		400	100		2				D
116	BRAMBLE GARDNER		FUNK	76		325	130		1	20			D
117	HAROLD REEVES		FUNK	76		125	10		4	20			D
118	EVELYN MCCARTY	240000 0P54000	FUNK	76		275	75		1	80			D
119	DIXIE OR OLLIE LAWSON	244430 0A62750	FUNK	76		250			1	75			D
120	BILL MCCLELLAN		FUNK	76		75	15		35	20			D
121	DOROTHY H BRUMMITT	244650 0836700	FUNK	76		100			30	45			D
122	RONALD MEADE		FUNK	76		225	27		2	21			D
123	BOR MOORE		FUNK	76		600	130		10	20			D
124	SAMMY FLEMING		FUNK	76		200			1				D
125	GLENN TEASLEY		FUNK	76		400	25						D
126	R R HICKS		FUNK	76		200							D
127	TEDDY HUNSAKER		FUNK	76		400	175		1				D
128	IDA B TATE		FUNK	76		100	30		25				D
129	JOE ALOOMER		FUNK	76		150	45		8				D
130	JIM BROWN		FUNK	76		200	15		7				D
131	JOHN HODGE		FUNK	76		275	100		15				D
132	J K ROBINSON		FUNK	76		495	50		3				D
133	JOE YODK		FUNK	76		205	50		150				D
134	ENTER MT COAL CO		FUNK	76		500	90		5				D
135	TRAVELERS MOTEL		FUNK	76									D

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SUMMARY OF WATER WFL DATA FOR WISE COUNTY

SWCB NO.	OWNER	VA. PLANE NORTH	COORD EAST	DRILLER	YR COMP	ELFV	TOTAL DEPTH	SWL PUMP LEVEL	ZONES OR SCREENS	YIELD RED- ROCK	FORM- ATION	LITH- OLOGY	LOGS TYPE
176	CLINCHFIELD COAL CO			FUNK	76		538 176		4				IND
177	AUSTIN POWDER CO			FUNK	76		200 10		40				IND
178	LARRY F DOTSON	287400	0836800	FUNK	76		125	10	10				DOM
179	WALEY CARROLL	232250	0839000	FUNK	76		275 150		3				DOM
180	PHILLIP MOORE	226200	0863400	FUNK	76		475						DOM
181	ERNEST PANNELL	279400	0832400	FUNK	76		125 40		50				DOM
182	GARE HUGHES	304150	0836800	FUNK	76		125 15		40				DOM
183	RILL COOMER			FUNK	76		175 30		30				DOM
184	CHARLOTTE GORDON	243600	0836750	FUNK	76		175 25		50				DOM
185	RENNY WAMPLER			FUNK	76		275						DOM
186	VERNON BRANHAM			FUNK	76		200		3				DOM
187	RICHARD MILLER			FUNK	76		200		15			SS	DOM
188	EARNEST DOOLEY	224700	0847400	FUNK	76		150		1				DOM
189	E ROSE			FUNK	76		275 125		1				DOM
190	J K ROBINSON			FUNK	76		500 160	777	1				DOM
191	EMMITT PIPPIN	243700	0837100	FUNK DRIL	77		250 40						DOM
192	MERSHELL VANCE			FUNK DRIL	77		150						DOM
193	GARFIELD ELLIS			FUNK DRIL	77		50						DOM
194	JOSEPH GENTRY			FUNK DRIL	77		175 40					SS	DOM
195	DORIS SELFE			FUNK DRIL	77		175 50		100				DOM
196	LESTER C MULLINS			FUNK DRIL	77		250		4				DOM
197	J T ADAMS			FUNK DRIL	77		100 40		50				DOM
198	BOB STANSBERRY	256700	0840000	FUNK DRIL	76		225 50		20				DOM
199	GLENN DALE BOLLING			FUNK DRIL	77		175 75		3				DOM
200	FREDDIE GIPSON			FUNK DRIL	77		175 40		12			MT	DOM
201	ROYCE STERRGILL			FUNK DRIL	77		175 45		90			SS	DOM
202	DONALD MCREYNOLDS			FUNK DRIL	77		175 75		50			SS	DOM
203	JOE BRICKEY			FUNK DRIL	77		250 75		60			SH	DOM
204	GIPSON TEXACO SS			FUNK DRIL	76		100 40		50				DOM
205	CONRAD MULLINS			FUNK DRIL	77		500 245		1				DOM
206	TRACY ROGGS				77	1900	65					SS	DOM
207	CHARLES CLAYTOR				77	1610						SS	DOM
208	TRIPLE J COAL CO 2				77	2000			50			SH	IND
209	HOWARD C. MULLINS			FUNK	77		150 90		20				DOM
210	GREG RELCHER			FUNK	77		100 35		40				DOM
211	E. D. BREEDING			FUNK	77		175 75		6				DOM
212	LINDA OSORNE	237400	0830900	FUNK	77		100 6		30				DOM
213	HOGUE F. BARNETT JR.			FUNK	77		250 150		2				DOM
214	TOM GREAR			FUNK	77		250 100		60			ROT	DOM
215	HADLEY MULLINS			FUNK	77		175 15		2				DOM
216	WINDALL THACKER			FUNK	77		75 10		60				DOM
217	CLINCHFIELD PILGRIM#2			FUNK	77		302 175		16				IND
218	CREED C. ROLLING			FUNK	77		100 15		100				DOM
219	RETTY MCCLLOUD	243300	0821400	FUNK	77		175 10		60				DOM
220	CLINCHFIELD BOUSER RR			FUNK	77		360 150		1				IND

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SUMMARY OF WATER WELL DATA FOR WISE COUNTY

SWCH NO.	OWNER	VA. PLANE COORD NORTH EAST	DRILLER	YR COMP	ELFV	TOTAL DEPTH	PUMP LEVEL	ZONES OR SCREENS	YIELD	RED-ROCK	FORM-ATION	LITH-ology	LOGS TYPE
191	CLINCHFIELD HOUSE #2		FUNK	77	77	245	75		16				IND
192	RUFORD SANDERS		FUNK	77	77	100	15		70				DOM
193	DAVID FRENCH		FUNK	77	77	60	10		50				DOM
194	GRATT MONK		FUNK	77	77	500	153		1				DOM
195	HAROLD HUGHES		FUNK	77	77	400	175		1				DOM
196	CLAUDE ELKINS		FUNK	77	77	175	10		10				DOM
197	ROGER I. MCNE	242800 0821500	FUNK	77	77	275	70		1				DOM
198	DANNY ROBINETTE		FUNK	77	77	120							DOM
199	TOM KENNEDY WISE, VA.		FUNK	77	77	245							DOM
190	JACK BLANTON		FUNK	77	77	200	40		30				DOM
191	MILLARD DAVIS		FUNK	77	77	95							DOM
192	FLAT WOODS JOE CORPS		YEAR	66	66	802	108	500	5				FG ARD

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SUMMARY OF WATER WELL DATA FOR WISE COUNTY

TOTAL NUMBER OF WELLS = 192

PARAMETER	OBSERVATIONS	MAXIMUM	MINIMUM	MEAN
ELEVATION	48	2765	1450	1953
TOTAL DEPTH	169	875	15	257
STATIC WATER LEVEL	103	575	1	82
PUMPING WATER LEVEL	12	777	40	374
YIELD	123	300	1	31
DEPTH TO BEDROCK	16	125	9	36

APPENDIX C

SUMMARY OF GROUND WATER QUALITY ANALYSES FOR WISE COUNTY

The following pages have been compiled from computer print-out sheets for the Wise County area. The information from which they were obtained are on permanent file in the offices of the Virginia State Water Control Board. The locations of many of the wells may be found in Appendix A.

VIRGINIA STATE WATER CONTROL BOARD

***** EXPLANATION OF TABLE *****

THE VIRGINIA STATE WATER CONTROL BOARD MAINTAINS A FILE OF WATER-QUALITY ANALYSES OF GROUND WATER FROM SELECTED WELLS AND SPRINGS. THE FOLLOWING TABLE IS A SUMMARY OF THESE ANALYSES. ADDITIONAL INFORMATION IS AVAILABLE FOR MANY OF THESE WELLS AND SPRINGS AND CAN BE OBTAINED BY CONTACTING THE BUREAU OF SURVEILLANCE AND FIELD STUDIES.

SWCB NO (STATE WATER CONTROL BOARD NUMBER): SEQUENTIAL NUMBER APPLIED TO WELLS WITH INFORMATION ON FILE. WHEN REQUESTING ADDITIONAL INFORMATION, PLEASE REFER TO THIS NUMBER.

OWNER AND/OR PLACE: ORIGINAL OR CURRENT OWNER OF THE WELL AND/OR ITS GEOGRAPHIC LOCATION.

DATE SAMP (DATE SAMPLED): MONTH AND YEAR IN WHICH THE WATER SAMPLE WAS COLLECTED.

PH: A PARAMETER WHICH INDICATES WHETHER WATER IS ACIDIC OR BASIC. A PH VALUE OF 7.0 INDICATES WATER WHICH IS NEUTRAL. A PH VALUE OF LESS THAN 7.0 INDICATES THAT WATER IS ACIDIC AND A PH VALUE OF GREATER THAN 7.0 INDICATES THAT WATER IS BASIC. A PH VALUE OF LESS THAN 6.5 OR GREATER THAN 8.5 IS CONSIDERED BY THE HEALTH DEPARTMENT TO BE A SECONDARY CONTAMINANT.

SPEC COND (SPECIFIC CONDUCTANCE): THE ABILITY OF WATER TO CONDUCT AN ELECTRIC CURRENT AS A RESULT OF DISSOLVED MINERAL MATTER. USED AS AN APPROXIMATE INDICATOR OF THE AMOUNT OF DISSOLVED MINERALS IN WATER. UNIT OF MEASURE IS MICROMHOS PER CENTIMETER.

T-DIS SOLID (TOTAL DISSOLVED SOLIDS): A MEASURE OF THE TOTAL AMOUNT OF DISSOLVED MINERAL MATTER IN WATER. UNIT OF MEASURE IS MILLIGRAMS PER LITER.

HARDNESS-TOTAL: A PARAMETER WHICH INDICATES THE EFFECTS OF CALCIUM, MAGNESIUM, AND OTHER METALS ON THE ABILITY OF WATER TO MAKE SOAP LATHER. UNIT OF MEASURE IS MILLIGRAMS PER LITER EXPRESSED AS CALCIUM CARBONATE.

HARDNESS-CALCIUM, MAGNESIUM: HARDNESS CONTRIBUTED BY CALCIUM AND MAGNESIUM. THE PRINCIPAL METALS WHICH CAUSE HARDNESS IN WATER. NOTE-BECAUSE TOTAL HARDNESS IS DETERMINED BY CHEMICAL TITRATION, WHEREAS CALCIUM-MAGNESIUM HARDNESS IS A MATHEMATICAL CALCULATION, CALCIUM-MAGNESIUM HARDNESS VALUES MAY BE HIGHER THAN TOTAL HARDNESS VALUES.

FE (IRON): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 0.3 MG/L, IRON IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

MN (MANGANESE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 0.05 MG/L, MANGANESE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

CA (CALCIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

MG (MAGNESIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

NA (SODIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

K (POTASSIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

ALK (ALKALINITY): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

SO4 (SULFATE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 250 MG/L, SULFATE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

CL (CHLORIDE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 250 MG/L, CHLORIDE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

NO3-N (NITRATE AS NITROGEN): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 10 MG/L NITRATE NITROGEN IS CONSIDERED TO BE A PRIMARY CONTAMINANT BY THE HEALTH DEPARTMENT.

NOTE: ALL ZEROS INDICATE PARAMETER ANALYZED BUT NOT DETECTED

VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUND WATER QUALITY ANALYSES, WISE COUNTY

SWCR NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL Ca.MG	FE	MN	CA	MG	NA	K	ALK	504	CL	N3/N
1	CLINCHFIELD COAL CO	12/74	6.5	495	548	278	307	31.30	0.72	82.0	25.0	40.0	1.3	127	96.0	2.0 0.00
3	BUDDY'S DINE & DANCE	5/74	8.6	750			13	0.00	4.0	0.8	180.0	13.7	315		48.0	0.00
4	WISE COUNTY JAIL	8/79	6.3	255	135	104	90	6.42	0.13	24.0	7.4	1.0	100		11.0	0.00
4	WISE COUNTY JAIL	9/77	6.1	80	26	14	17	0.76	0.03	5.0	1.0	9.0	11	2.0	22.5	
4	WISE COUNTY JAIL	6/77				92	139	8.60	0.15	41.0	9.0	1.0				
4	WISE COUNTY JAIL	4/76		180		74	94	24.00	0.76	24.0	8.2	24.0		4.6		0.00
4	WISE COUNTY JAIL	4/76		180		74	94	24.00	0.76	24.0	8.2	24.0		4.6		0.00
4	WISE COUNTY JAIL	1/76	6.5		115	66	79	9.15	0.17	19.0	7.8	1.0	79	4.0	15.0	0.00
7	MARTY CORP	12/74	6.6	160	183	78	87	0.70	0.05	24.0	6.6	15.5	92	11.0	3.0	0.00
7	MARTY CORP	7/72	7.7		76			0.10	0.00				124	2.0	4.0	
8	OBSERVATION WELL #52	11/71	6.5	310	179		132	0.44		28.0	15.0	14.0		31.0	24.0	0.10
18	ST PAUL COLA-COLA	4/74	7.5		366	268	325	0.20		81.0	30.0	15.0	255	32.0	9.0	4.10
19	TOWN OF COEBURN	11/48	7.8				34	3.00	0.04	10.3	1.9			18.1	20.5	
20	CLINCH R IND DEV CORP	9/67	7.4				84	0.02	0.05	24.9	5.3	15.2		6.5	3.0	0.10
20	CLINCH R IND DEV CORP	8/67	7.4				93	0.02	0.01	28.1	5.5	14.0		5.7	2.0	0.10
21	TOWN OF WISE	2/42	4.6				147	0.10		37.2	13.1			5.1	2.3	
22	TOMS CREEK	4/55						0.20								
23	ODLE'S CHRYSLER-PLY.	11/78	6.4	304	149		110	25.00	0.26	31.0	8.0	13.0	138		7.0	0.00
23	ODLE'S CHRYSLER-PLY.	7/74	6.6	200	159	82	102	2.80		29.0	7.3	9.8	116	6.4	2.0	0.00
25	WISE COUNTY	6/74	7.9	180	125	37	36	0.53	0.06	11.0	2.0	22.7	89	1.1	2.0	0.00
25	WISE COUNTY	4/73	7.5		40			0.13	0.00				100	0.0	0.0	
26	SUNRISE COAL CORP.	8/77	6.6	225	148	192		6.25	2.70				115		5.5	
26	SUNRISE COAL CORP.	5/77	6.7	240	158	127	141	7.20	2.60	30.0	16.0	5.0	113	13.9	8.0	
26	SUNRISE COAL CORP.	2/77	7.0		153	122		6.60				0.5	121	18.0	5.4	
26	SUNRISE COAL CORP.	10/76	6.5	220	116	116	132	4.30	3.40	28.0	15.1	5.0	111	8.6	4.5	0.20
26	SUNRISE COAL CORP.	7/76	6.6	290	242	151		15.40	2.40			0.8	128	20.0	14.0	
26	SUNRISE COAL CORP.	2/76	6.7	220	159	46		0.34	0.02				119	9.0	2.0	
26	SUNRISE COAL CORP.	5/72	8.1		76			0.00					60		4.0	
27	WESTMORELAND COAL CO.	2/76	6.5	260	186	98	73	3.10	0.23	20.0	5.6	65.0	133	14.1	2.5	
27	WESTMORELAND COAL CO.	1/72	7.9		80			0.00	0.00				136	9.0	8.0	
28	JOHN KILGORE	8/79	6.3	356	230	144	175	12.00	0.40	57.0	8.0	26.0	128	54.0	7.4	0.00

NOTE: ALL ZERCS INDICATE PARAMETER ANALYZED BUT NOT DETECTED

VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUND WATER QUALITY ANALYSES, WISE COUNTY

WCR NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL CA, MG	FE	MN	CA	MG	NA	K	ALK	SO4	CL	N3/N
28	JOHN KILGORE	5/72	6.9			160		0.00					140		12.0	
29	JOHN MARKHAM	8/77	6.7	622	411	300	0.20	0.04					305	15.0	12.1	2.50
29	JOHN MARKHAM	5/77	6.8	590	444	335	444		140.0	23.0	8.0	3.0	322	24.8	16.0	2.50
29	JOHN MARKHAM	2/77	7.1		405	346	0.40						320	14.4	9.4	
29	JOHN MARKHAM	10/76	6.9	590	590	344	442	0.30	0.05	31.0	5.0	2.2	326	17.2	2.5	1.90
29	JOHN MARKHAM	7/76	7.1	660	464	369	0.26	0.05					343	4.0	16.0	0.03
29	JOHN MARKHAM	4/74	6.7		200	140	151	7.00	39.0	13.0	11.0	1.6	95	5.4	6.0	0.40
30	WILLIAM SLUGS	4/74	7.0		185	134	119	2.10	39.0	5.2	12.0	1.2	100	16.8	9.0	
32	HUBERT GIBSON	5/74	6.8	260			135	15.00	36.0	11.0	13.0	7.9	117		9.0	0.00
34	GILMER LITTON	5/74	8.3	800			56	0.40	13.0	5.8	170.0	1.3	397		13.0	0.00
36	RAY RICHANAN	8/74	6.9	217	148	114	123	0.90	32.0	10.5	6.5	0.7	124	1.5	0.0	0.00
37	CENTRAL DRIVE-IN THEA	8/74	6.6	160	101	66	68	11.00	18.0	5.5	10.5	1.0	76	13.7	0.0	0.00
38	WESTMORELAND COAL CO	8/74	6.7	220	153	62	67	5.30	20.0	4.2	1.4	27.5	104	17.1	1.0	0.00
45	VA IRON COAL & COKE	8/79		1032			266	8.70	1.50	100.0	4.0	3.0				
46	VA IRON COAL & COKE	8/79		880			491	14.00	1.30	131.0	40.0	3.0				
47	VA IRON COAL & COKE	8/79		839			383	51.00	2.80	81.0	44.0	1.0				
48	VA IRON COAL & COKE	8/79		957			214	2.00	0.59	56.0	18.0	2.0				
51	CLINCH RIVER IND DEV	9/67	7.3			88	84	0.02	0.04	24.8	5.3	3.2	115	6.5	3.0	0.10
53	JIMS MINUTE MART	12/74	5.9	215	183	120	132	37.40	1.44	27.0	15.6	0.9	56	65.6	11.0	0.00
54	SHOP SANITARY LANDFIL	6/77	6.8		924	558	774	8.00	0.60	180.0	79.0	5.0	175	476.0	5.0	
54	SHOP SANITARY LANDFIL	2/77	6.9		931	620		6.59	0.99				180	454.0	48.0	
54	SHOP SANITARY LANDFIL	10/76	6.7	820	973	571	668	7.06	0.94	141.0	77.0	4.4	178	428.0	3.0	0.00
54	SHOP SANITARY LANDFIL	10/76	6.7	820	973	571	668	7.60	0.94	141.0	77.0	4.4	178	428.0	3.0	
54	SHOP SANITARY LANDFIL	7/76	7.1	1000	971	589		5.05	0.56				180	436.0	4.5	0.00
54	SHOP SANITARY LANDFIL	7/76	7.1	1000	971	587		5.50	0.56				180	436.0	4.5	
54	SHOP SANITARY LANDFIL	4/76	6.5	980	928	609	457	6.50	0.87	137.0	28.0	4.0	185	484.0	2.0	0.00
54	SHOP SANITARY LANDFIL	4/76	6.5	980	928	556	457	6.05	0.87	137.0	28.0	4.0	185	484.0	2.0	0.00
54	SHOP SANITARY LANDFIL	1/76	6.9		937	597	609	2.68	0.60	127.0	71.0	4.0	175	480.0	3.0	0.00
54	SHOP SANITARY LANDFIL	12/74	6.9	700	874	584	657	5.60	0.78	156.0	65.0	3.8	175	450.0	1.5	0.00
55	OLD BEN COAL CO	12/74	7.0	380	378	170	200	2.70	0.20	57.0	14.0	1.5	130	146.0	1.0	0.00

NOTE: ALL ZEROS INDICATE PARAMETER ANALYZED BUT NOT DETECTED

VIRGINIA STATE WATER CONTROL BOARD
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SUMMARY OF GROUND WATER QUALITY ANALYSES, WISE COUNTY

SWCR NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	CA	MG	NA	K	ALK	SO4	CL	N3/N		
58	APPALACHIA ELEM SCH#2	10/78	7.9	409	259	35	37	0.40	0.02	10.0	3.0	87.0	2.0	208	12.8	2.5
58	APPALACHIA ELEM SCH#2	2/76	7.0	310	216	68	57	1.40	0.05	16.0	4.2	75.0	5.2	140	22.0	1.5
59	WESTMORELAND COAL CO	5/75	6.8	380	342	146	43		9.0	5.0	2.7	40.0	183	100.2	1.0	0.00
60	WESTMORELAND COAL CO	5/75	7.4	580	444	64	49	0.50	0.00	18.0	1.0	170.0	2.4	360	26.0	1.0
61	WESTMORELAND COAL CO	5/75	6.4	120	112	48	52	0.00	0.00	19.0	1.1	5.5	1.2	30	31.5	1.0
62	WAYNE STEELE	5/75	6.1	49	4	36	21	1.60	0.18	4.0	2.6	4.5	0.5	22	4.7	1.5
63	E J SULLIVAN JR	12/75	6.9	240	163	80	87	1.14	0.05	24.0	6.5	31.0	1.5	110	20.4	2.0
64	W L RICHIE	7/75	5.2	77	51	0	22	1.43	0.10	6.0	1.8	4.3	1.6	20	6.6	2.0
65	FRANKLIN TACKITT	10/75	5.7	100	67	44	22	9.60	0.50	5.0	2.3	1.0	1.7	23	14.0	12.0
66	ALBERT J KINZER	10/75	9.2	520	390	20	10	0.00	0.00	3.0	0.6	159.0	0.2	289	0.0	10.0
67	WILLIAM CANTRELL	10/75	6.9	270	210	128	128	2.50	0.10	32.0	11.8	7.0	0.6	101	68.0	1.0
68	JOE BLEDSOE	3/79	7.9	674	408	22	40	0.14		12.7	1.9	178.0	3.1		198.0	10.5
68	JOE BLEDSOE	11/75	8.4	680	534	25	31	0.06		10.0	1.4	152.0	2.3	161	189.0	11.6
69	PAUL RRYINGTON	3/79	6.6	190	146	56	67	0.38		19.2	4.7	2.7	19.0		8.5	6.50
69	PAUL RRYINGTON	11/75	6.7	156	156	114	125	0.15		35.0	9.1	1.0	2.2	117	8.0	2.5
70	CARL R STURGILL	3/79	7.1	188	103	92	102	0.10		32.8	4.8	2.5	1.1		19.0	5.5
70	CARL R STURGILL	11/75	7.1	170	170	96	105	0.03		35.0	4.3	1.0	0.3	84	15.0	1.5
71	BEN SPRADLIN	3/79	6.8	186	104	72	74	0.31	0.46	20.1	5.7	4.7	1.3		22.0	0.5
71	BEN SPRADLIN	11/75	6.6	130	109	63	71	0.12	0.40	20.0	5.2	1.0	0.5	65	9.0	0.5
72	BOBBY WRIGHT	12/75	6.6	190	156	67	73	3.10	0.30	18.0	6.9	27.0	1.7	98	7.0	3.0
73	JAMES T EVANS	12/75	7.3	260	202	118	105	4.25	0.48	26.0	9.8	28.0	2.3	153	10.0	0.5
81	BOB MOORE	8/79	5.6	172	127	0	6	0.40	0.00	2.0	0.3	50.0	0.5	61	8.4	8.9
84	JUNIOR & GLENN HAMILTON	8/79	6.1	89	53	44	38	5.30	0.32	12.0	2.0	3.0	1.0	42		3.0
91	PAUL F MULLINS	8/79	7.4	7665	4436	140	175	0.20	0.00	47.0	14.0	2480.0	7.0	665	0.0	0.00
94	BLACKWOOD FUEL CO	2/76	6.3	190	139	78	88	2.70	0.20	25.0	6.2	17.0	1.1	68	31.2	1.5

NOTE: ALL ZEROS INDICATE PARAMETER ANALYZED BUT NOT DETECTED

VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUND WATER QUALITY ANALYSES. WISE COUNTY

SWCR NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL CA, MG	FE	MN	CA	MG	NA	K	ALK	SO4
														CL
														N3/N
106	CITY OF NORTON	10/78	6.8	170	112	46	53	1.40	0.11	18.0	2.0	2.0	84	4.2
107	JOE SLOCE	5/76	6.6	210	189	107	111	3.60	0.08	29.0	9.3	12.0	105	13.2
108	JIM STURGILL	5/76	5.8		146	81	84	3.10	1.50	19.0	9.0	10.0	29	24.2
109	PHYLLIS DEAN	5/76	6.2	160	245	2	61	0.16		18.0	3.8	17.0	51	4.2
110	WILLY CLISSO	5/76	6.4		285	36	156	3.80	0.85	40.0	13.7	8.0	101	84.0
111	DAYL COOMER	8/79		399			75	0.23	0.24	19.0	6.8	58.0		
112	VERMON SCRUGGS	4/79	6.5	225	160	88	91	0.60	0.10	24.0	7.6			6.4
118	EVELYN MCCARTY	8/79		279			87	0.42	0.06	25.0	6.0	4.4		2.1
121	DOROTHY H BRUMMITT	8/79	6.3	76	207	138	154	1.60	0.08	50.0	7.0	23.0	124	7.9
124	SAMMY FLEMING	4/79	6.9	630	477	999	76	0.30	0.06	19.0	7.0	106.0		49.6
135	TRAVELERS MOTEL	9/78	7.0	755	732	47	45		0.10	13.0	3.0	300.0	202	124.0
137	AUSTIN POWDER CO	10/78	6.4	262	194	37	95	24.00	1.05	25.0	8.0	9.0		18.0
139	WALEY CARROLL	8/79	5.6	111	69	44	37	0.16	0.01	11.0	2.3	6.0	48	0.0
140	PHILLIP MOORE	9/79	6.5	495	272	92	99	0.04	0.04	28.0	7.1	98.0	177	0.0
141	ERNEST PANNELL	8/79	6.7	319	191	100	133	0.27	0.05	44.0	5.6	45.0	139	0.0
142	GABE HUGHES	8/79	6.7	489	296	0	1	0.04	0.00	0.5	0.0	171.0	225	0.0
144	CHARLOTTE GORDON	8/79	6.4	318	200	144	161	1.70	0.14	53.0	7.0	16.0	125	21.2
144	CHARLOTTE GORDON	4/79	6.6	315	216	136	137	1.70	0.16	44.0	6.5	2.0		18.8
146	VERNON BRANHAM	4/79	7.2	324	263	60	67	0.30		18.0	5.3	51.0		6.7
148	EARNEST DOOLEY	8/79	6.4	135	153	120	102	0.09	0.02	29.0	7.1	9.0	132	0.0
152	HERSHFLL VANCE	8/79	5.8	398	297	160	199	2.50	0.47	50.0	18.0	12.0	60	190.0
153	GARFIELD ELLIS	8/79	5.7	253	69	36	30	8.50	0.27	8.0	2.5	13.0	74	0.0
164	GIBSON TEXACO SS	10/78	7.0	324	248	125	140	7.10	0.27	38.0	11.0	21.0	136	
														16.5

NOTE: ALL ZEROS INDICATE PARAMETER ANALYZED BUT NOT DETECTED

VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUND WATER QUALITY ANALYSES, WISF COUNTY

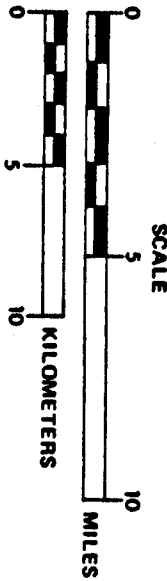
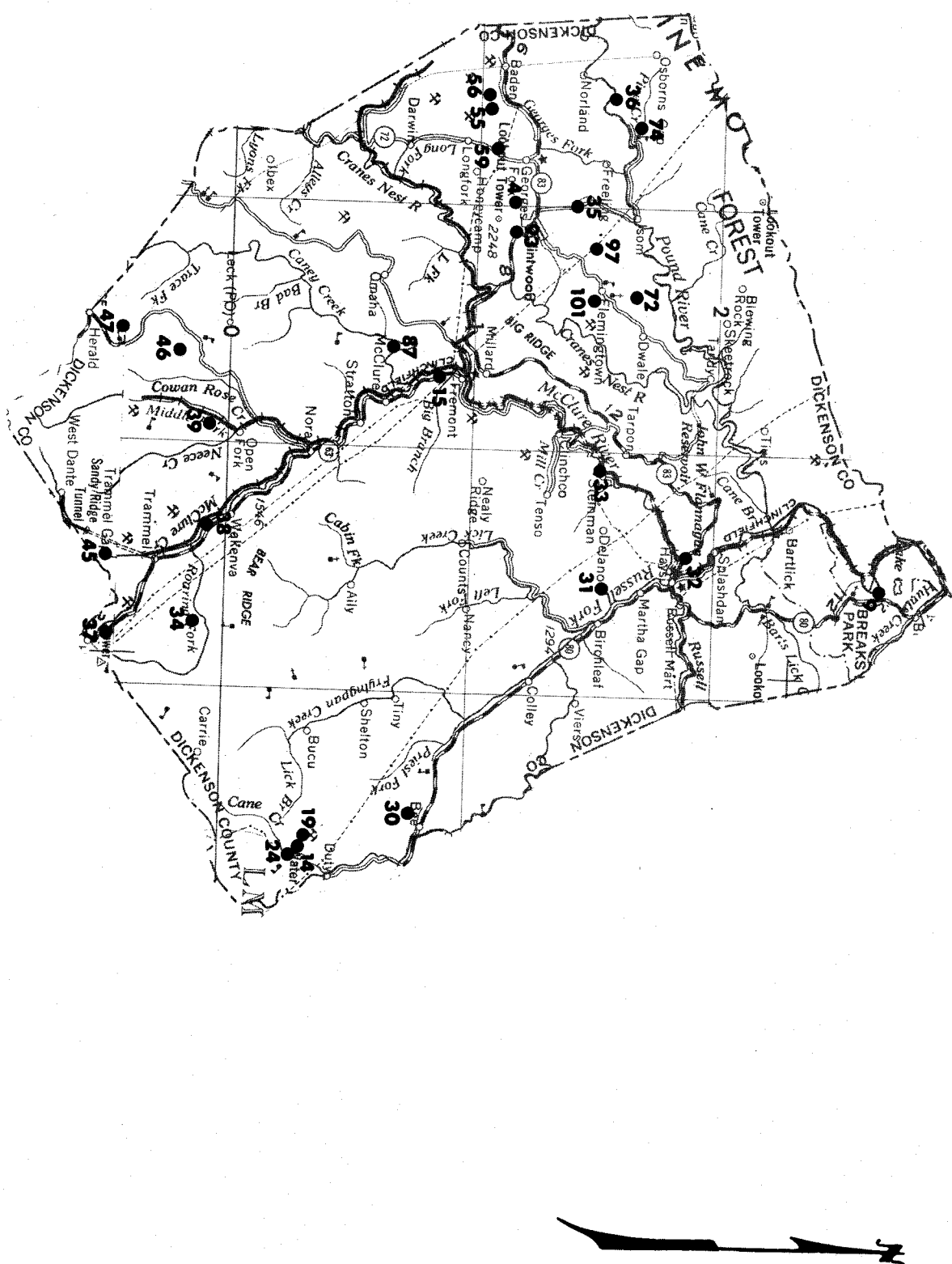
 SWCB OWNER AND/OR PLACE DATE PH SPEC T-DIS HARDNESS FE MN CA MG NA K ALK SO4 CL N3/N
 NO SAMP 8/79 6.4 237 151 100 119 0.92 0.10 33.0 9.0 17.0 1.4 131 0.0 2.0 0.00
 172 LINDA OSBORNE 8/79 6.2 417 214 160 652 0.79 0.08 47.0 130 28.0 3.4 176 21.8 11.0 0.00
 195

APPENDIX D

KEY WATER WELLS IN DICKENSON COUNTY

The following Dickenson County map shows approximately 25 wells which are included in Appendix E. The numbers appearing next to each well may be cross-referenced with the information contained in Appendices E and F.

KEY WATER WELLS IN DICKENSON COUNTY



APPENDIX E

SUMMARY OF WATER WELL DATA FOR DICKENSON COUNTY

The following pages have been compiled from computer print-out sheets for the Dickenson County area. The printout is updated to include information from new Water Well Completion Reports submitted by water well drilling contractors. The locations of many wells may be found in Appendix D.

VIRGINIA STATE WATER CONTROL BOARD

***** EXPLANATION OF TABLE *****

THE VIRGINIA STATE WATER CONTROL BOARD MAINTAINS A FILE OF WATER-QUALITY ANALYSES OF GROUND WATER FROM SELECTED WELLS AND SPRINGS. THE FOLLOWING TABLE IS A SUMMARY OF THESE ANALYSES. ADDITIONAL INFORMATION IS AVAILABLE FOR MANY OF THESE WELLS AND SPRINGS AND CAN BE OBTAINED BY CONTACTING THE BUREAU OF SURVEILLANCE AND FIELD STUDIES.

SWCB NO (STATE WATER CONTROL BOARD NUMBER): SEQUENTIAL NUMBER APPLIED TO WELLS WITH INFORMATION ON FILE. WHEN REQUESTING ADDITIONAL INFORMATION, PLEASE REFER TO THIS NUMBER.

OWNER AND/OR PLACE: ORIGINAL OR CURRENT OWNER OF THE WELL AND/OR ITS GEOGRAPHIC LOCATION.

DATE SAMP (DATE SAMPLED): MONTH AND YEAR IN WHICH THE WATER SAMPLE WAS COLLECTED.

PH: A PARAMETER WHICH INDICATES WHETHER WATER IS ACIDIC OR BASIC. A PH VALUE OF 7.0 INDICATES WATER WHICH IS NEUTRAL. A PH VALUE OF LESS THAN 7.0 INDICATES THAT WATER IS ACIDIC AND A PH VALUE OF GREATER THAN 7.0 INDICATES THAT WATER IS BASIC. A PH VALUE OF LESS THAN 6.5 OR GREATER THAN 8.5 IS CONSIDERED BY THE HEALTH DEPARTMENT TO BE A SECONDARY CONTAMINANT.

SPEC COND (SPECIFIC CONDUCTANCE): THE ABILITY OF WATER TO CONDUCT AN ELECTRIC CURRENT AS A RESULT OF DISSOLVED MINERAL MATTER. USED AS AN APPROXIMATE INDICATOR OF THE AMOUNT OF DISSOLVED MINERALS IN WATER. UNIT OF MEASURE IS MICROMHOS PER CENTIMETER.

T-DIS SOLID (TOTAL DISSOLVED SOLIDS): A MEASURE OF THE TOTAL AMOUNT OF DISSOLVED MINERAL MATTER IN WATER. UNIT OF MEASURE IS MILLIGRAMS PER LITER.

HARDNESS-TOTAL: A PARAMETER WHICH INDICATES THE EFFECTS OF CALCIUM, MAGNESIUM, AND OTHER METALS ON THE ABILITY OF WATER TO MAKE SOAP LATHER. UNIT OF MEASURE IS MILLIGRAMS PER LITER EXPRESSED AS CALCIUM CARBONATE.

HARDNESS-CALCIUM, MAGNESIUM: HARDNESS CONTRIBUTED BY CALCIUM AND MAGNESIUM. THE PRINCIPAL METALS WHICH CAUSE HARDNESS IN WATER. NOTE-BECAUSE TOTAL HARDNESS IS DETERMINED BY CHEMICAL TITRATION, WHEREAS CALCIUM-MAGNESIUM HARDNESS IS A MATHEMATICAL CALCULATION, CALCIUM-MAGNESIUM HARDNESS VALUES MAY BE HIGHER THAN TOTAL HARDNESS VALUES.

FE (IRON): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 0.3 MG/L, IRON IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

MN (MANGANESE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 0.05 MG/L, MANGANESE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

CA (CALCIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

MG (MAGNESIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

NA (SODIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

K (POTASSIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

ALK (ALKALINITY): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

SO4 (SULFATE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 250 MG/L, SULFATE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

CL (CHLORIDE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 250 MG/L, CHLORIDE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

NO3-N (NITRATE AS NITROGEN): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 10 MG/L NITRATE NITROGEN IS CONSIDERED TO BE A PRIMARY CONTAMINANT BY THE HEALTH DEPARTMENT.

NOTE: ALL ZEROS INDICATE PARAMETER ANALYZED BUT NOT DETECTED

VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF WATER CONTROL MANAGEMENT
SUMMARY OF WATER WELL DATA FOR DICKENSON COUNTY

DATE 01/19/84

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SWR NO.	OWNER	VA. PLANE COORD NORTH EAST	DRILLER	YP COMP	ELEV	TOTAL DEPTH	SWL PUMP LEVEL	ZONES OR SCREENS	YIELD RED- ROCK	FORM- ATION	LJTH- OLOGY	LOGS TYPE
1	TOWN OF CLINTWOOD		GRIFFITH	49		350	45	295	40	51	PW	PWS
2	TOWN OF CLINTWOOD		GRIFFITH	49		249	32	77	75	5	PW	PWS
3	TOWN OF CLINTWOOD		FUNK	69		400	60		32		PW	PWS
4	CLINTWOOD HIGH SCHOOL		FUNK	69		405	90		12		PW	PUR
5	CLINTWOOD HIGH SCHOOL		FUNK	69		505	150		3		PW	PUR
6	RIG CANEY WATER CORP		FUNK	70		95	20		120		P	PWS
7	CLINCHFIELD COAL CO		RURKE	70		365	70		15	20	P	IND
8	CLINCHFIELD COAL CO		KEEN	70		298			3	3	P	IND
9	BREAKS INTERST PARK		CYPHERS	60		203	32		5	18	P	PUR
10	CLINCHFIELD COAL CO		KEEN	71		160	55		30		SH	IND
11	CLINCHFIELD COAL CO		KEEN	71		300	37		30	40	SH	IND
12	CLINCHFIELD COAL CO		KEEN	71		300			52	PNG	SS	IND
13	CLINCHFIELD COAL CO		KEEN	71		100			17	PNG	SH	IND
14	CLINCHFIELD COAL CO		KEEN	5A		340	75		40		SS	IND
15	VA DEPT HIGHWAYS	310350 0867500	BARNETT		1470	90	3		2000	PNG	SS	PUR
16	MCCLURE WATER CO					178	100			P		PWS
17	MCCLURE WATER CO					245	50		20	PW	SH	COM
18	FVAL RISE		FUNK	72		380	82		2	P	SH	ARO
19	CLINCHFIELD COAL CO		KEEN	72		245	40		60	P	SS	IND
20	CLINCHFIELD COAL CO		KEEN	72		320	75	320	20	PENN	SS	IND
21	CLINCHFIELD COAL CO		FUNK	71		393						IND
22	CLINCHFIELD COAL CO					208						IND
23	CLINCHFIELD COAL CO					302						IND
24	CLINCHFIELD COAL CO											IND
25	CLINCHFIELD COAL CO											IND
26	BIG CANEY WATER CORP					203			200			DOM
27	BIG CANEY WATER CORP					125			100			DOM
28	W A AUSTIN											DOM
29	US CORPS OF ENGINEERS											DOM
30	FREEMAN EDWARDS											DOM
31	DICKENSON CO SCHOOLS	305500 0929900			1440	86						DOM
32	ALVIN PUCKETT	331100 0900000			1280	98	18					DOM
33	LEON STANLEY	344050 0893250		73	1250	54						DOM
34	RILLY K HARRIS	331800 0881200			1340	83						DOM
35	ROLEY PHIPPS	280100 0940000			2020	52	32					DOM
36	FRANK G VAKOVER	329650 0846550			1590	6A						DOM
37	MRS PEGGY KISEH	332950 0833300			1480	100						DOM
38	WOODROW RASNAKE	267203 900009			2080							DOM
39	ERVINTON HIGH SCHOOL	277920 887697			1590	51						DOM
40	V L BIRD	280315 873594			1560	175						PUR
41	CLINCHFIELD COAL CO					235			25			
42	BREAKS COMMISSION #1		MULLENS		252				32			
43	BREAKS COMMISSION #2		MULLENS		625				2			
44	CAMP ZARAHFELA		FUNK	75	250				30			
45	GLEN ROYD	264750 893010			275	30			50			PWS

VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF WATER CONTROL MANAGEMENT

DATE 01/19/84

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SUMMARY OF WATER WELL DATA FOR DICKENSON COUNTY 125

SWCB NO.	OWNER	VA. PLANE COORD NORTH EAST	DRILLER	YP COMP	ELEV	TOTAL SWL PUMP LEVEL	ZONES OR SCRFFNS	YIELD	RED- ROCK	FORM- ATION	LITH- OLOGY	LOGS TYPE
46	HARRY L STANLEY	276300 865395	FUNK	75	2300 505	40						DOM
47	WILLARD FREEMAN		FUNK	75	2710 85	50						DOM
48	MARTY MATERIALS		FUNK	74	200 50	1						COM
49	HAYMON HILL		FUNK	74	375 80	1						DOM
50	DALLAS HALE		FUNK	74	300 225	2						DOM
51	HAMPTON ST CLAIR		FUNK	74	175	1						DOM
52	JASSIE L CORMAN		FUNK	74	75	1						DOM
53	RENNY BROWN		FUNK	74	275 90	1						DOM
54	DONALD STANLEY		FUNK	74	100 30	7						DOM
55	OLIVER KENDRICK JR	317200 0830300	FUNK	74	250 100	50						DOM
56	WELDON COLLEY	317200 0827200	FUNK	74	225 30	50						DOM
57	CLINCHFIELD COAL CO		FUNK	74	300 140 300	40						DOM
58	CUMBERLAND COLLIERIES		FUNK	74	225 40	30						IND
59	LUCIAN SMITH	318000 0838500	FUNK	74	100 25	20						DOM
60	DALE SMITH		FUNK	74	400 175	1						DOM
61	ELBERT MULLINS		FUNK	74	350 67	3						DOM
62	JIMMY RORINSON #2		FUNK	74	275	1						DOM
63	JIMMY PRICE		FUNK	74	225 192	1						DOM
64	JERRY PRICE		FUNK	74	125 15	2						DOM
65	GLEN STANLEY		FUNK	74	125 20	30						DOM
66	LOYD RLEVINS		FUNK	74	275 60	2						DOM
67	KENNETH MEADE		FUNK	74	200 150							DOM
68	DARRELL HIBBITTS		FUNK	74	175							DOM
69	JAMES BAKER		FUNK	74	125 50	4						DOM
70	GEORGE CHOWK		FUNK	74	500	2						DOM
71	H STANLEY		FUNK	74	100 50	50						DOM
72	C SYKES	334900 0858900	FUNK	74	175 40	2						DOM
73	JESS DAVIS	334000 0835200	FUNK	74	175 40	15						DOM
74	EARL LFE	319800 0834350	FUNK	74	175 100	4						DOM
75	LEON DAVIS		FUNK	74	325 165	1						DOM
76	JOSEPH RATLIFF		FUNK	74	100 15	20						DOM
77	J D RORINSON		FUNK	74	275 65	1						DOM
78	DWAYNE MULLINS		FUNK	74	325 230	1						DOM
79	CLARENCE DINGUS		FUNK	74	125							DOM
80	COVEY FLKINS #1		FUNK	74	700 210	1						DOM
81	COVEY FLKINS #2		FUNK	74	700 230	2						DOM
82	COVEY FLKINS #3		FUNK	74	700 175	1						DOM
83	HONEY CAMP COAL CO		FUNK	74	275							DOM
84	HONEY CAMP COAL CO		FUNK	74	175 65							IND
85	ELKINS COAL #4 WELL#1		FUNK	74	700							IND
86	ELKINS COAL #4 WELL#2		FUNK	74	500 140	4						IND
87	THYSSEN WINE MCCLURE I	304400 0864300	FUNK	74	225 30 180	90						DOM
88	DALE MEADE		FUNK	74	600 168	1						DOM
89	EDWARD FLEMING		FUNK	77	325 150	1						DOM
90	CURTIS PALMER		FUNK	77	275 50	2						DOM

VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF WATER CONTROL MANAGEMENT

DATE 01/19/84

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SUMMARY OF WATER WFL DATA FOR DICKENSON COUNTY

SWCB NO.	OWNER	VA. PLANF COORD NORTH	DRILLER	YP COMP	ELEV	TOTAL DEPTH	SML PUMP LEVEL	ZONES OR SCREENS	YIELD	RED-ROCK	FORM-ATTION	LITH- OLOGY	LOGS TYPE
91	STEVE SMITH		FUNK	77		275	100		15			SS	DOM
92	DOUGLAS RAMSEY		FUNK	77		275	90		1			SS	DOM
93	ELMER LAMBERT	321200 0848200	FUNK	77		195	145		100				DOM
94	ROBBY RHANKAM		FUNK	77		400	71		1				DOM
95	FARRIS COLLEY		FUNK	77		275	40		6				DOM
96	DAVID WILLIS		FUNK	77		275	55		2				DOM
97	R. C. FLEMING	334100 0851050	FUNK	77		300	85		1				DOM
98	JAMES F. TICKLES		FUNK	77		400	60		1				DOM
99	PAUL CHILDRESS		FUNK	77		400	128		1				DOM
100	OLIVER KENDRICK		FUNK	77		750	225		4				DOM
101	STEPHEN BROWN	332100 0857500	FUNK	77		125	30		12				DOM
102	CLINCHFIELD COAL CO.		FUNK	77		310	100	0000	130				IND
103	CLINCHFIELD COAL CO.		FUNK	77		315	127	402	8				IND
104	HAROLD MULLINS, POUND								1				DOM
105	U S DEPT OF HUD								3				PWS
106													

VIRGINIA STATE WATER CONTROL BOARD
 BUREAU OF WATER CONTROL MANAGEMENT
 SUMMARY OF WATER WFL DATA FOR DICKENSON COUNTY 125

DATE 01/19/84
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TOTAL NUMBER OF WELLS = 106

PARAMETER	OBSERVATIONS	MAXIMUM	MINIMUM	MEAN
ELEVATION	14	2710	1250	1749
TOTAL DEPTH	100	750	51	271
STATIC WATER LEVEL	69	230	3	86
PUMPING WATER LEVEL	7	402	77	277
YIELD	77	2000	0	50
DEPTH TO BEDROCK	16	200	0	33

APPENDIX F

SUMMARY OF GROUND WATER QUALITY ANALYSES FOR DICKENSON COUNTY

The following pages have been compiled from computer printout sheets for the Dickenson County area. The information from which they were obtained are on permanent file in the offices of the Virginia State Water Control Board. The locations of many of the wells may be found in Appendix D.

VIRGINIA STATE WATER CONTROL BOARD

***** EXPLANATION OF TABLE *****

THE VIRGINIA STATE WATER CONTROL BOARD MAINTAINS A FILE OF WATER-QUALITY ANALYSES OF GROUND WATER FROM SELECTED WELLS AND SPRINGS. THE FOLLOWING TABLE IS A SUMMARY OF THESE ANALYSES. ADDITIONAL INFORMATION IS AVAILABLE FOR MANY OF THESE WELLS AND SPRINGS AND CAN BE OBTAINED BY CONTACTING THE BUREAU OF SURVEILLANCE AND FIELD STUDIES.

SVCH NO (STATE WATER CONTROL BOARD NUMBER): SEQUENTIAL NUMBER APPLIED TO WELLS WITH INFORMATION ON FILE. WHEN REQUESTING ADDITIONAL INFORMATION, PLEASE REFER TO THIS NUMBER.

OWNER AND/OR PLACE: ORIGINAL OR CURRENT OWNER OF THE WELL AND/OR ITS GEOGRAPHIC LOCATION.

DATE SAMP (DATE SAMPLED): MONTH AND YEAR IN WHICH THE WATER SAMPLE WAS COLLECTED.

PH: A PARAMETER WHICH INDICATES WHETHER WATER IS ACIDIC OR BASIC. A PH VALUE OF 7.0 INDICATES WATER WHICH IS NEUTRAL. A PH VALUE OF LESS THAN 7.0 INDICATES THAT WATER IS ACIDIC AND A PH VALUE OF GREATER THAN 7.0 INDICATES THAT WATER IS BASIC. A PH VALUE OF LESS THAN 6.5 OR GREATER THAN 8.5 IS CONSIDERED BY THE HEALTH DEPARTMENT TO BE A SECONDARY CONTAMINANT.

SPEC COND (SPECIFIC CONDUCTANCE): THE ABILITY OF WATER TO CONDUCT AN ELECTRIC CURRENT AS A RESULT OF DISSOLVED MINERAL MATTER, USED AS AN APPROXIMATE INDICATOR OF THE AMOUNT OF DISSOLVED MINERALS IN WATER. UNIT OF MEASURE IS MICROMHOS PER CENTIMETER.

T-DIS SOLID (TOTAL DISSOLVED SOLIDS): A MEASURE OF THE TOTAL AMOUNT OF DISSOLVED MINERAL MATTER IN WATER. UNIT OF MEASURE IS MILLIGRAMS PER LITER.

HARDNESS-TOTAL: A PARAMETER WHICH INDICATES THE EFFECTS OF CALCIUM, MAGNESIUM, AND OTHER METALS ON THE ABILITY OF WATER TO MAKE SOAP LATHER. UNIT OF MEASURE IS MILLIGRAMS PER LITER EXPRESSED AS CALCIUM CARBONATE.

HARDNESS-CALCIUM, MAGNESIUM: HARDNESS CONTRIBUTED BY CALCIUM AND MAGNESIUM. THE PRINCIPAL METALS WHICH CAUSE HARDNESS IN WATER. NOTE-BECAUSE TOTAL HARDNESS IS DETERMINED BY CHEMICAL TITRATION, WHEREAS CALCIUM-MAGNESIUM HARDNESS IS A MATHEMATICAL CALCULATION, CALCIUM-MAGNESIUM HARDNESS VALUES MAY BE HIGHER THAN TOTAL HARDNESS VALUES.

FE (IRON): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 0.3 MG/L, IRON IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

MN (MANGANESE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 0.05 MG/L, MANGANESE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

CA (CALCIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

MG (MAGNESIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

NA (SODIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

K (POTASSIUM): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

ALK (ALKALINITY): UNIT OF MEASURE IS MILLIGRAMS PER LITER.

SO4 (SULFATE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 250 MG/L, SULFATE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

CL (CHLORIDE): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 250 MG/L, CHLORIDE IS CONSIDERED TO BE A SECONDARY CONTAMINANT BY THE HEALTH DEPARTMENT.

NO3-N (NITRATE AS NITROGEN): UNIT OF MEASURE IS MILLIGRAMS PER LITER. IN CONCENTRATIONS GREATER THAN 10 MG/L NITRATE NITROGEN IS CONSIDERED TO BE A PRIMARY CONTAMINANT BY THE HEALTH DEPARTMENT.

NOTE: ALL ZEROS INDICATE PARAMETER ANALYZED BUT NOT DETECTED

VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUND WATER QUALITY ANALYSES, DICKENSON COUNTY

SWR NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL CA, MG	FE	MN	CA	MG	NA	K	ALK	SO4	CL N3/N
4	CLINTWOOD HIGH SCHOOL	10/78	6.7	415	277	125	133	4.00	0.33	35.0	11.0	48.0	3.0	161	49.0 14.0
9	BREAKS INTERST PARK	6/60	7.6				5.60	0.22							0.9 0.30
15	VA DEPT HIGHWAYS	7/74	7.1	205	149	120	113	2.60	33.0	7.4	14.3	1.2	82	11.9	6.0 0.00
16	MCCLURE WATER CO	9/64	3.0				AN1 17.65	9.92	105.0	131			0	170A.1	
17	MCCLURE WATER CO	11/78	69.0	427	255	134	141	5.00	0.64	40.0	10.0	2.0	146	50.0	24.0
17	MCCLURE WATER CO	1/52					85	0.15	0.20	29.9	2.6			3.0	
18	EVAL RISE	10/78	6.6	412	298	178	203	5.40	0.41	55.0	16.0	2.0	143	54.0	17.0
19	CLINCHFIELD COAL CO	11/78	8.3	833	512	14	14	0.30	4.0	1.0	2.2		341	9.4	697.0
20	CLINCHFIELD COAL CO	11/78	6.5	268	183	68	75	3.30	0.38	20.0	6.0	1.0	80	62.0	2.0 0.12
23	CLINCHFIELD COAL CO	5/75	7.3	520	362	180	130	0.85	52.0	0.1	90.0	1.1	178	72.4	15.0 0.00
27	BIG CANEY WATER CORP	2/69					98	0.19		0.2			96		
27	BIG CANEY WATER CORP	2/69						3.90		0.2					
30	FREEMAN EDWARDS	9/74	7.1	280	201	144	154	1.80	44.0	10.8	10.1	0.8	126	22.8	8.0 0.00
32	ALVIN PUCKETT	9/74	6.8	350	274	176	206	5.00	59.0	14.4	9.5	1.8	90	96.0	6.0 0.00
33	LEAON STANLEY	9/74	6.8	280	180	98	99	6.70	27.0	7.7	40.0	1.0	118	0.0	27.0 0.00
35	ROLEY PHIPPS	9/74	7.5	365	249	44	51	0.20	14.0	3.8	79.0	1.0	206	5.2	0.0 0.00
36	FRANK G VANOVER	9/74	7.8	330	199	56	40	0.20	12.0	2.5	80.0	1.1	166	5.1	10.0 0.00
37	MRS PEGGY KISER	3/75	7.0	260	154	78	108	0.68	0.48	31.0	7.4	0.8	122	22.1	3.5 0.20
38	WOODROW RASNAKE	3/75	7.3	260	156	70	97	0.83	0.08	30.0	5.5	1.0	125	1.0	14.0 0.00
39	ERVINTON HIGH SCHOOL	9/78	6.6	247	161	78	95	4.00	0.40	28.0	6.0	2.0	92	28.0	7.5
39	ERVINTON HIGH SCHOOL	3/75	6.4	180	100	70	99	4.20	0.38	30.0	5.9	1.0	74	12.2	5.0 0.00
41	CLINCHFIELD COAL CO	2/75	7.9	460	318	162	151	0.13	0.00	40.8	12.0	3.7	123	128.4	1.5 0.00
44	CAMP ZAPAPENLA	6/75	6.3	223	176	48	47	0.90	0.09	11.0	4.7	1.1		6.8	2.1
45	GLEN ROYD	7/75	6.8	760	694	589	824	5.70	1.12	210.0	73.0	0.8	63	195.0	0.5 0.00

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VIRGINIA STATE WATER CONTROL BOARD
BUREAU OF SURVEILLANCE AND FIELD STUDIES

SUMMARY OF GROUND WATER QUALITY ANALYSES, DICKENSON COUNTY

SWCB NO	OWNER AND/OR PLACE	DATE SAMP	PH	SPEC COND	T-DIS SOLID	HARDNESS TOTAL	CA	MG	NA	K	ALK	504	CL	N3/N			
46	HARRY L STANLEY	7/75	6.9	250	165	2	3	0.08	0.10	1.0	0.2	55.0	0.4	125	3.4	11.5	0.00
47	WILLARD FREEMAN	7/75	4.9	55	27	2	20	10.40	0.25	4.0	2.4	2.7	0.3	10	6.3	2.0	0.00
48	MARTY MATERIALS	10/78	6.4	322	203	126	147	13.00	0.65	34.0	15.0	9.0	2.0	139	21.6	13.0	
58	CUMBERLAND COLLIERIES	10/78	7.5	365	253	57	65	0.30	0.02	18.0	5.0	66.0	2.0	178	2.2	13.0	
79	CLARENCE DINGUS	10/79	7.2	237	146	104	119	0.92	0.10	33.0	9.0	17.0	1.4	120	19.0	5.0	0.00
80	COVEY ELKINS #1	10/79	6.6	141	66	44	29	18.80	0.61	3.4	5.1	2.0	0.0	61	4.0	12.5	0.00
87	THYSSFN MINE MCCLURE1	9/78	7.0	527	368	266	299	0.13	95.0	15.0	14.0	2.0	2.0	229	62.0	5.5	
89	EDWARD FLEMING	10/79	6.6	177	108	12	8	0.07	0.01	3.0	0.2	38.0	0.0	81	4.0	3.0	0.00
97	R. C. FLEMING	9/79	5.8	436	300	192	224	0.49	0.18	46.0	26.5	17.0	3.6	59	178.0	2.0	0.12
102	CLINCHFIELD COAL CO.	9/78	6.1	736	627	350	374	12.00	0.95	97.0	32.0	18.0	3.0	39	420.0	2.0	
107		10/78	7.1	911	659	328	335	0.10	0.40	75.0	36.0	87.0	2.0	235	257.0	12.0	0.06
107		9/78	6.7	637	450	194	209	5.50	0.28	59.0	15.0	67.0	3.0	180	176.0	12.0	

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GLOSSARY

A-horizon	The uppermost zone of a soil profile, from which soluble salts and colloids have been leached, and organics have accumulated, i.e., topsoil.
Alluvium	Detritus deposited by water in geologically recent time.
Anticline	A convex fold or arch of rock strata with the two edges or limbs dipping in opposite directions from the crest.
Aquiclude	A formation with such a low permeability as to render it useless as a source of water or conveyance of recharge.
Aquifer	A formation, group of formations, or part of a formation that is water bearing.
Arenaceous	Rocks that contain sand.
Argillaceous	Rocks that contain large amounts of clay.
Axis	The linear trend of the axis of an anticline, or the trough of a syncline.
Bedding	Planes which divide sedimentary rocks of the same or different composition.
Bedrock	Any solid rock either exposed at the surface, or overlain by soil or unconsolidated deposits.
B-horizon	A zone of soil below the A-horizon in which soluble salts, colloids, and fine mineral particles accumulate.
Bog	Swamp or wet land commonly covered by decaying vegetation or peat.
Breccia	A sedimentary rock consisting of angular detrital fragments cemented together by finer material.
Calcareous	Containing calcium carbonate (CaCO_3).
Carbonate Rock	A rock consisting largely of a mineral or minerals containing the radical CO_3^{--} .
Cementation	The precipitation of a binding material around minerals or rock grains. An example would be a quartz cemented sandstone.

C-horizon	The weathered zone of a soil profile directly beneath the B-horizon, and extending down to unweathered rock.
Clastic Rock	A sedimentary rock composed of fragmented materials derived from pre-existing rocks.
Colluvium	Gravity transported loose deposits usually found at the foot of a slope or cliff.
Compaction	A decrease in the volume of sediments due to the compression of overlying strata.
Cone of Depression	A conical depression in the water table that is formed around a water well when it is being pumped.
Conglomerate	A clastic sedimentary rock consisting of rounded rocks or minerals cemented together by a finer matrix.
Degradation	The process of lowering a land surface by erosion.
Denudation	The laying bare of a strata by removing its cover or overburden.
Detritus	Accumulations resulting from the breaking up and decay of pre-existing rocks.
Dip	The angle at which a rock bed is inclined from the horizontal.
Discharge	The volume of a stream flow, per unit of time, through a given cross section of the stream.
Dissection	The transformation by erosion of flat upland areas into rugged hills, valleys and ravines.
Dolomite	A sedimentary rock composed largely of calcium magnesium carbonate ($\text{CaMg}(\text{CO}_3)_2$).
Drawdown	The depth to which the water table is lowered below the static level due to well pumping.
Evapo-transpiration	The portion of precipitation which is returned to the air by evaporation and vegetation.
Fault	A fracture or fracture zone along which there has been displacement of the two sides relative to one another, and parallel to the fracture. The displacement may be a few inches or many miles.
Fault Breccia	An assembly of broken rock fragments frequently found along faults. They are often recemented.

Fissile	A property of splitting easily along closely spaced parallel planes. Thin bedded shales are often fissile.
Flood Plain	An area adjacent to a river (or stream) which is composed of sediments deposited by the river, and which is covered by water when the river overflows its banks during flooding.
Flowing Well	A well from which water flows at the surface without pumping due to hydrostatic pressure.
Fold	A bend in the rock strata.
Formation	A geologic mapping unit consisting of a large and persistent stratum of common rock.
Fossils	The remains or traces of plants or animals preserved in rock.
Fracture	A break in a rock usually due to faulting or intense folding.
Ground Water	Subsurface water below the water table in the zone of saturation.
Hydrologic Cycle	The cycle in which water is evaporated from the sea, precipitates from the atmosphere, infiltrates into the land, and returns either to the sea or atmosphere by transportation, evaporation or transpiration.
Impervious	The term applied to a bed or stratum through which water will not move under normal hydrostatic pressure.
Infiltration	The flow or movement of water through the soil surface into the ground.
Interstitial Water	Water contained in the small pores or spaces between the grains of rock.
Joint	A rock fracture, usually vertical to bedding, along which no appreciable movement has occurred.
Karst Topography	The name given to terrains that are underlain by limestones and dolomites that have been weathered and dissolved by ground water, forming such features as caves, sinkholes, disappearing and reappearing streams. Named after the Karst Mountains of the eastern Adriatic.
Leaching	The process by which soluble mineral compounds are removed in solution by percolating ground waters.

Limestone	A sedimentary rock consisting predominantly of calcium carbonate (CaCO_3).
Lithology	The physical character of a rock as can be determined visually by the unaided eye, or with a small power (10 x) hand lens.
Marsh Gas	Methane. Derived from the decay of plant tissue. Often found in the ground water of coal producing regions. Often known as "fire-damp" in coal mining regions.
Outcrop	The part of a rock formation which appears at the surface.
Peat	A dark brown residue formed by partially decomposed vegetation in bogs and swamps. The formation of peat beds is the first stage in the development of coal.
Perched Water Table	Ground water which lies above the regional water table, but is separated from it by an impervious strata.
Permeability	The capacity of rock or soil to transmit a fluid. It is measured by the rate at which a fluid of a standard viscosity can move a given distance over a certain period of time.
Pervious Rock	A stratum or formation that contains voids through which water will move under normal hydrostatic conditions.
Poorly Graded Deposits	Unconsolidated deposits of essentially the same grain size. Such deposits have a high porosity.
Porosity	The ratio of the volume of voids of a rock or soil to the total volume. This ratio is usually expressed as a percent.
Potentiometric Surface	The level to which ground water rises in a well or an aquifer. In a water table or unconfined aquifer it is the water table; in an artesian or confined aquifer, it is the piezometric surface, also called the artesian head: water level above the top of the penetrated aquifer.
Pyrite	Iron sulfide (FeS_2). A mineral often associated with coal deposits and believed to contribute both iron and sulfur compounds to the ground water.

Quartzite	A firm sandstone in which silica has grown between the individual grains.
Recharge	The addition of water to an aquifer by natural infiltration or artificial means.
Residual Soil	Soil formed in place by the disintegration and decomposition of the underlying rock.
Runoff	Water which flows on the surface, such as in streams.
Saltwater Encroachment	The replacement of fresh ground water by brackish or saline water, often due to the overpumping of an aquifer.
Sandstone	A sedimentary rock consisting predominantly of sand-size particles.
Saprolite	A thoroughly decomposed, earthy, but untransported rock.
Sedimentary Rocks	Those rocks formed by the consolidation of accumulated sediments in water (aqueous) or air (eolian). The sediments may be rock fragments (sandstones, shales); animal or plant remains (limestones, coal); or the product of chemical action or evaporation (salt, gypsum). The deposits are layered, and nearly flat as deposited.
Shale	A laminated sedimentary rock consisting largely of clay-sized particles. In coal mining regions these rocks are often termed "slate."
Sinkhole	A land surface depression usually found in limestone regions. They are often topographic reflections of collapsed subsurface caves. Sinkholes are also found in regions underlain by salt and gypsum.
Slate	A metamorphosed shale with well developed fissility. Also a coal miner's term for any shale which accompanies coal.
Solution Cavities	Openings in limestones and other soluble rocks caused by percolating water.
Specific Yield	The volume of water (expressed as a percent) that a fixed volume of rock or soil will surrender to a well. For example, if 100 cubic feet of saturated rock with a porosity of 25 percent yields 15 gallons of water to a well, the specific yield will be 15 percent.

Stratum	A single sedimentary bed or layer, regardless of thickness.
Strike	The bearing of a horizontal line on the plane of a stratum, joint, fault, or cleavage plane. It is perpendicular to the direction of dip.
Structure	The general disposition, attitude, arrangement, or relative positions of the rock masses of a region.
Subsidence	The lowering of the earth's surface. It may be extensive, such as the relative lowering of portions of continents, or local due to over-pumping of ground water, collapsed mines, or consolidation of soils in fill areas.
Syncline	A concave fold or trough of rock strata with the two edges or limbs dipping in the same direction toward the axis of the trough.
Talus	A pile of coarse waste at the foot of a cliff or steep slope.
Terrace Deposits	Deposits of alluvium which are elevated, usually level, older flood plains, and which are bounded by an escarpment.
Topography	The relief and form of land surface.
Unconformity	An old erosion surface that separates younger strata from older rocks.
Vadose Water	Subsurface water in the zone of aeration, above the zone of saturation.
Water Table	The upper surface of the zone of saturation. The surface in a water table aquifer at which the water level stands.
Water Well	An artificial excavation placed into the ground to such a depth as to penetrate water-yielding rock or deposits, thus allowing the removal of that water by flow or pumping.
Weathering	A complex set of natural processes, both chemical and mechanical, involving the decay and breaking up of rocks.

Well Graded
Deposits

Unconsolidated deposits consisting of a wide distribution of grain sizes from extremely fine to large. Because the finer particles fill the voids between the larger particles, well graded deposits have lower porosities than poorly graded deposits.

Zone of
Aeration

The zone in which permeable rock interstices are not filled (except occasionally) with water.

Zone of
Saturation

The zone in which an aquifer is saturated with water under pressure equal to or greater than atmospheric pressure.

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VIRGINIA STATE WATER CONTROL BOARD
P. O. Box 11143, 2111 North Hamilton Street
Richmond, Virginia 23230
(804) 257-0056

- | | |
|--|--|
| <p>1 Southwest Regional Office
 408 East Main Street
 P. O. Box 976
 Abingdon, VA 24210
 (703) 628-5183</p> | <p>4 Piedmont Regional Office
 4010 West Broad Street
 P. O. Box 6616
 Richmond, VA 23230
 (804) 257-1006</p> |
| <p>2 West Central Regional Office
 Executive Park
 5312 Peters Creek Road
 P. O. Box 7017
 Roanoke, VA 24019
 (703) 982-7432</p> | <p>5 Tidewater Regional Office
 287 Pembroke Office Park
 Suite 310 Pembroke No. II
 Virginia Beach, VA 23462
 (804) 499-8742</p> |
| <p>3 Northern Regional Office
 5515 Cherokee Avenue, Suite 404
 Alexandria, VA 22312
 (703) 750-9111</p> | <p>6 Valley Regional Office
 116 North Main Street
 P. O. Box 268
 Bridgewater, VA 22812
 (703) 828-2595</p> |

